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THE ELECTRICAL OPERATION OF RAILWAYS IN ENGLAND.

As has been pointed out a number of times, one of the important phases of the electrification of railways in England is that of handling the suburban traffic of large towns in this way. Certain of these new systems have now been in operation for a year or more, and the reports for last year are most interesting.

In some cases the reports of working were not as satisfactory as had been hoped, but, in general, there were reasons for this condition. In one case the electric trains were run between the steam trains, so that the full benefits of the new system could not be realized.

The general result of the change has been an increase in the traffic and an increase in the gross receipts. There has also been an increase in the cost of operation as a whole, but, considering the greater service given, the cost per train-mile has been reduced. One of the most satisfactory reports is that of the suburban lines of the Northeastern Railway Company, which serve the thickly settled district near Newcastle. The new system was put into service in this district about eighteen months ago. During the last six months of 1905 the number of passengers increased twenty-three per cent compared with the same period of the previous year. The gross receipts increased about seventeen per cent and running costs had increased about twelve per cent, due, as mentioned above, to an increase in the number of trains. The cost per train-mile was considerably decreased. This is said to have been for last year eighteen cents per train-mile, which includes repairs and depreciation of rolling stock. For steam operation the figure was thirty-five cents.

THE ELECTRICAL DRIVE IN THE MACHINE SHOP.

Some exceedingly valuable as well as interesting data on the motor drive for machine tools are given on another page of this issue by Mr. George M. Campbell. Mr. Campbell gives also some acceptable suggestions for selecting the size of motors and the method of control. He lays stress upon the importance of speed regulation, which is so easily accomplished by a number of electrical methods, and he gives figures illustrating the actual performance of tools of various kinds, made under ordinary shop conditions. Results of tests made to determine the amount of power lost in the motors and due to the machines themselves are also included in this paper.

It is interesting to note that for certain classes of machine tools the power required to make the cut is less than that necessary to get ready for it. This condition obtains particularly in planers and tools of that type, where, in order to save time, the return stroke is made at a higher speed than the cut. Such a tool will absorb power at a greater rate during the return stroke than during the cut, though on account of the higher speed it is for a shorter time. The demand on the motor at the moment of reversing preparatory to cutting is also more severe than that when reversing at the end of the cut.

Machines in which the work is periodic, though the machine does not reverse, can be helped out considerably by a judicious use of flywheels. For example, a punch mentioned by Mr. Campbell, when piercing a one and one-quarter-inch sheet with a one and one-quarter-inch hole called on its motor for about twenty-one horse-power. A similar punch doing the same work,

but supplied with a flywheel, required less than eight horsepower.

The figures given in this paper will be very useful to anyone who is looking into the electrical operation of a machine shop. It would be interesting, however, if some comparative figures could be obtained showing the gains secured through the electric drive. A saving in power is important, but is not the most important way in which the electrical drive is an improvement. By means of it it is possible to increase considerably the quality and the quantity of the output of the shop. Figures relative to such gains are hard to obtain, at least in such shape that they admit of a comparison between the old and the newer methods of driving; but they would be exceedingly valuable.

SAVE THE WATER POWERS.

We are just beginning to realize the very great value to us of our water powers. Until electrical transmission of power demonstrated its applicability, water powers were at a disadvantage as compared with the steam engine, and but few of those which had been harnessed were kept at work. To-day we realize more fully the value of these sources of power, and we are already developing those most favorably situated. Vast sums of money are being spent in this way in order to obtain the cheap power which results.

But there are certain problems connected with this question which are not under the control of individuals. The continued destruction of the forests throughout the country has not only changed the character of the flow of many streams, but has also been the cause of many disastrous floods. A denuded country sheds its water rapidly, so that the effect of rain is merely to raise the water in the streams to an unusual height for a short time. For power development this is most undesirable. What one wishes is a uniform flow of water throughout the year. On the other hand, where the head waters of a stream lie in forest land, where the water as it falls is held for some time in the ground, the flow is more uniform throughout the year and floods are reduced to a minimum. For these reasons it is of great importance in order to preserve our water powers that we should start by preserving the forests where the streams rise. In this way we will be killing two birds with one stone, for we will not only protect the water power, but insure the country against floods.

The problem of preserving forests is an exceedingly difficult one. It can only be undertaken by the states or the federal government, and since in many cases the problem is really an extrastate one, it is often desirable that the federal government should take the proper steps. There are two districts in which legislation of this kind is urgently needed—the New England states and the South Atlantic states. The work can not be undertaken too soon, for the forests are being destroyed very rapidly.

A work related to this is that of surveying the water powers of the country in order to determine the possible location of sites and the annual run-off. This has been done already to some extent by the hydrographic bureau of the United States Geological Survey, and certain of the states have themselves issued valuable reports on the subject. France has recently taken up this question and will make a thorough survey of her water powers. The investigation will be general, including an examination of the navigability of the streams and the possible control of their flow. The forest problem will also be studied, the best methods of managing the forests and of replenishing them being given much attention.

ANALOGIES.

The instructor in electrical science has probably to resort more frequently to the use of analogies in order to bring home to his students a realization of the principles which he is trying to instil than teachers of other subjects. He is dealing with something that can not be perceived by the ordinary use of our senses—something that makes itself known by causing motion of an object, by heating a wire, or in some similar way; and to talk about this thing, or whatever it be, and to explain the laws which it obeys without at the same time dwelling upon the physical actions which it brings about, generally serves rather to mystify the initiate into the new science than to convey a definite idea to him. The instructor, therefore, is almost forced to adopt analogies: to compare the transfer of electrical energy from point to point to the flow of water through a pipe, to build up an imaginary magnetic field out of stretched elastic bands, or to adopt the many other devices which will enable the student to follow the argument until he learns sufficient about the science to think of it more abstractly. But, unfortunately, one phase of the use of analogies, which is too frequently neglected by the instructor, is to warn the student against unwarranted use of the tool put in his hands. The student only too frequently assumes that the flow of electricity along a wire—as we are accustomed to say—corresponds in every respect to the flow of water through a pipe, and he proceeds to draw further deductions, often far from true. The instructor should therefore never fail to state explicitly that any analogy must be applied only so far, and its limitations are such and such. Not infrequently the analogy can be used correctly further than it is applied in the specific case under consideration, but it is always dangerous, for the beginner at least, to attempt this extension. It is better to be ignorant on a subject than to hold incorrect views. The water analogy has done a world of good in teaching the beginner, but its injudicious use has given older students a world of trouble, because it is so hard to get an incorrect idea out of one's head.

This little sermon on analogies is called forth by a very pretty application of this method, which appears in this issue in the article by Mr. Budd Frankenfield, who compares the performance of a motor-balancing set with that of an auto-transformer. But Mr. Frankenfield, who knows from experience the danger involved in the use of this tool, specifically points out the limitations which apply in this case. In addition to this minor feature, Mr. Frankenfield's article itself is an exceptionally interesting study.

ELECTRICAL TRANSMISSION.

Electrical transmission of energy frequently lends itself to short distances of transmission as well as to great. While in efficiency and economy it is superior to any other method for distances measured in miles, it has other features which frequently make it superior where the distance of transmission is measured in yards. Such a condition exists, for example, in the modern shop. Even for still shorter distances—measured perhaps by a few feet—not infrequently the conditions are such that an electrical system can give better results than a more direct method. Where the problem of controlling the power transmitted is important, a better result may often be secured by the somewhat roundabout transformation from mechanical power into electrical power, a short transmission, and a retransformation back into mechanical power. Indeed, the question of control may be so vital as to call for what amounts to practically a triplicate equipment—that is to say, instead of driving directly by the prime mover we cause it to drive a dynamo, and the dynamo to drive a motor; and each of these three machines must have a rating somewhat approximating that which would suffice for the prime mover were it used alone.

Such an arrangement is attracting a good deal of attention to-day as applied to the propulsion of vehicles. It is being used for large commercial automobiles, the prime mover being a gasoline engine, which drives a dynamo which supplies the power to the motors geared to the wheels. A storage battery may be added to such a system to equalize the load, and so reduce somewhat the size of the generators and the engine. The system is also being tried on so-called motor cars employed for giving a more frequent service on steam railroads. Cars of this type are being tested in this country and in Europe, and although no definite figures have been given respecting the cost of such a service the results seem to be satisfactory. Only recently a car equipped in this way started on a trip across this country. The equipment consists of an internal-combustion engine, dynamo, small storage battery and motors. The car on trial runs attained high speeds, and was always under easy control. Its trip across the continent will be watched with interest, as it will serve to demonstrate the reliability of this particular equipment, at least, and give some indication of the cost of running such cars.

With such an equipment a car can be started with its greatest tractive effort and with practically no waste of power; it can be operated at almost any speed economically; the power is easily controlled, and the generating equipment is always working efficiently. The main feature of the system, however, is the method of control, which seems to warrant two additional transformations, each, of course, involving complications and some loss, though a part of the loss is offset by the increased efficiency at which the prime mover operates. The system as used to-day may seem somewhat complicated, and it is possible that it may eventually be simplified somewhat; but the control of the propelling power of a vehicle is of such great importance that the complications of a system are of small moment if the results obtained are better. Any one who has tried this or similar methods of controlling the running of a motor can not but feel confident that the electrical system will give a good account of itself.

EXCEPTIONAL OPPORTUNITY FOR ELECTRICAL REFRIGERATION.

By electrical refrigeration is meant merely the new system of automatically driving and controlling small mechanical refrigerating plants by means of an electric motor. This system has been brought forward within the past year or so, and its friends say that it is giving excellent results; that all things considered, it is cheaper than ice, and does away with much of the annoyance caused by the older system. Besides providing the objectionable daily replenishing of the boxes with ice, it gives a system of refrigeration which is always under control, and by means of which the cold rooms may be kept dry easily. The system is strongly recommended for all situations where a considerable amount of ice is necessary now, such, for example, as butcher shops, hotels, restaurants and drug stores.

It was pointed out some time ago that the exceptionally mild winter would probably affect the ice harvest, although at that time the ice companies said that they felt no anxiety about the supply. Now, only a month after this forecast, we are told that the harvest of ice is the poorest that can be remembered; that the supply so far secured and which can be obtained by forcing the artificial ice-making plants will be only a little more than one-third of the supply for 1905. One of the large companies has already started the erection of a large plant to help out the situation, and although we are still in the winter, the price of ice has been raised thirty-three per cent, with the prospect of a further increase in the latter part of the spring or the first of summer. This increase in the price of ice will increase considerably the cost of refrigeration during the coming summer, and for this reason an exceptional opportunity is offered to the dealers in small refrigerating plants and to the electrical power companies for introducing the new system. Indeed, a better chance could not be offered, for even though the cost of running the new system, through unfamiliarity on the part of those who operate it, should at first be somewhat more than it would be under the best conditions, the result can hardly fail to be satisfactory when compared with the unusual condition of the ice supply. The most should be made of this opportunity at once. Now is the time to introduce the new system to those who have been using ice. To delay will merely make it harder. The proprietor who puts in a machine will want to get as much service out of it as possible during the first year. If he manages to pull through half the summer with ice he probably will be content to worry along the rest of the year in the same old way; but now, with the whole spring and summer before us, with the price of ice just increased one-third and a warning that it will go still higher, the situation offered to the agent who wants to talk electrical refrigeration could not be better.

BALANCERS.

BY BUDD FRANKENFIELD.

A COMPARISON OF THE DIRECT-CURRENT MOTOR GENERATOR AND THE ALTERNATING-CURRENT AUTOTRANSFORMER.

This comparison is limited to symmetrical three-wire systems of distribution or systems in which the voltages

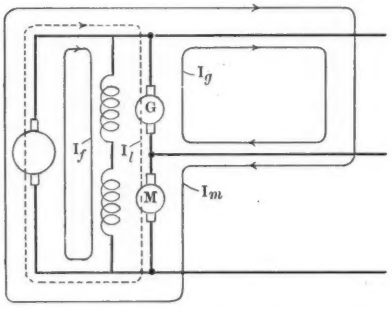


FIG. 1.—DIRECT-CURRENT, THREE-WIRE SYSTEM.

between either main and the neutral are approximately equal. Its interest lies in the remarkable parallelism inherent in the two classes of apparatus when operating on a simple resistance load, such as incandescent lamps.

At the outset let it be stated that the direct-current balancer is a piece of apparatus, the virtues of which are becoming more and more appreciated with every year of service. Its chief advantage lies in its adaptability to systems using standard generators of any make, thus avoiding the employment of three-wire generators of highly specialized design. On lighting circuits it operates without a thought on the part of the attendant, faithfully compensating for the somewhat fickle shifting of the load from side to side, and with a promptness and accuracy beyond human attainment, in the hand-regulated systems. On multiple voltage power circuits no load is too erratic, no change too violent, for it to follow with perfect ease. The balancer is to the network a faithful sentinel guarding against every attack upon the integrity of the regulation.

The autotransformer possesses many of the same good qualities, but can not attain the same efficacy in the matter of regulation. In addition, its duties are more severe in that it may be called upon to supply reactive currents, a factor with which a direct-current system does not have to contend. The autotransformer is little used in lighting circuits due to the employment of high primary voltages and three-wire transformers. It is, however, applicable to low-tension systems of generation and has been used to a limited extent.

Fig. 1 represents a direct-current, three-wire system, employing a balancer consisting of two like dynamo-electric machines M and G, mounted on a common base and mechanically coupled to rotate at the same speed. The two armatures are connected in series across the mains and, at their common point of connection, to the neutral of the system. The field windings are connected in series across the mains.

All current common to the two sides of the distributing system is furnished directly by the generating station, and the balancer is called upon only for the difference in current between the two sides—the neutral current. Balanced load then is zero load on the balancer and in dealing with the present problem all load is considered as confined to one side of the system, this load being understood as the

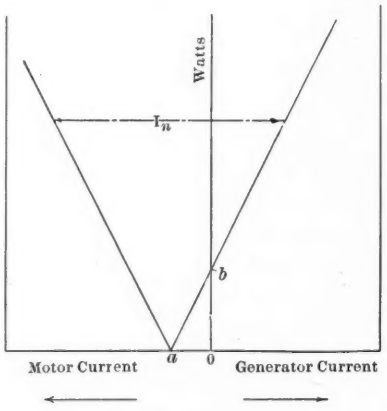


FIG. 2.—GRAPHIC REPRESENTATION OF DIRECT-CURRENT BALANCER.

excess of load on one side over that on the other.

At no load, balanced load on the system, the two machines act as motors running light. There is a magnetizing current I_f in the field windings and a loss current I_l in the armatures of sufficient magnitude to supply the equal stray power losses of the two machines. As the load becomes unbalanced, say in favor of the upper side of the system, the terminal pressure of the machine G approaches more nearly to the counter pressure and the loss current I_l becomes unequally divided, decreasing in G and increasing in M by an equal amount. The excess of this loss current in M is supplied by the establishment of a current I_m in the neutral. A further unbalancing still further decreases the loss current in G and increases the loss current in M until a point is reached where the loss current in G is zero and the machine M carries the entire loss current of the two machines. At this point G is acting as a generator operating at zero load, M as a motor under a load equal to the stray power of G, and the current I_m is equal to 2 I_l of the no-load condition. A further unbalancing establishes a current I_g, a generator current emanating from G, and increases the current I_m enough to supply I_g and its attendant losses. The field current I_f, of course, remains fixed for all loads with a fixed supply pressure.

Fig. 2 represents the above sequence graphically. Motor currents and generator currents are plotted respectively to the left and to the right of the zero. The vertical scale represent watts output of motor and watts intake of generator, and the horizontal distance between the two curves is the neutral current. At balanced load the distance O *a* represents the current I_l, a motor current equal in each machine. As the load becomes unbalanced the motor current of one machine decreases, and that of the other increases an equal amount. Finally, at a transmitted wattage between the two machines, equal to O *b*, the armature current of one machine is zero, and that of the other 2 I_l equal to I_m which is also the neutral current. A greater unbalancing introduces the generator current, as shown. Below the point *b* the neutral current represents the difference between two motor currents; above *b* it is the sum of the motor current I_m and the generator current I_g.

Fig. 3 represents an autotransformer operating under like conditions. It is

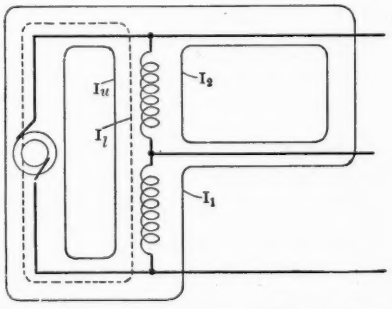


FIG. 3.—AUTOTRANSFORMER, THREE-WIRE SYSTEM.

assumed that the windings are of uniform cross section throughout, and that they are divided into coils intermeshed after the manner of the secondaries of three-wire transformers, so as to render leakage a negligible quantity, at least for the purpose in hand.

At balanced load there is a magnetiz-

ing current $I\mu$ common to the two circuits of the windings, and in quadrature with it a core loss current I_l, also common to both windings. These two currents combine vectorially to form the no load or leakage current of the transformer. The magnetizing component corresponds to the field current in the direct-current analogue, and remains constant regardless of the load. When the load is overbalanced on the upper side of the system the core-loss current in that side decreases, and the core-loss current in the lower side increases an equal amount. This establishes a primary current I_1 in that part of the winding connected to the lower side of the system. I_1 corresponds to the direct current I_m. As the unbalancing increases the core-loss current becomes less in the upper winding and greater in the lower, until finally it becomes zero in the first and of a value $I_1 = 2\ I_l$ in the second. At this point the upper winding is acting as a generator or secondary winding without load and the lower, as a motor or primary winding, supplying all of the core loss. A further unbalancing[1] establishes a secondary current I_2, corresponding to I_g, and the primary current is increased by an amount equal to I_2 plus the losses incident to its maintenance.

Referring now to Fig. 4, which is self-explanatory. O a $(= I_l)$ represents the loss current in the two coils at balanced load. It is a primary current, each coil acting as the primary of a transformer on no load. As the unbalancing increases the core-loss current in one coil approaches zero as a limit and that in the other coil $2\ I_l$ as a limit. The limit is satisfied at the point b where one coil is acting as secondary about to furnish current, and the other as primary assuming the entire burden of the losses. O b may be called the output of the primary at this point. It is equal in value to half the total core loss; *i. e.*, it is the loss once assumed by the now secondary coil, but at present thrown upon its mate. A further unbalancing establishes a secondary current as indicated. Below the point b the neutral current is the difference between two primary currents, and above b it is the sum of the primary current I_1 and the secondary current I_2.

The analogy on non-inductive load is thus complete. The critical point b would be indicated by an ammeter in the armature circuit of the generator (Fig. 1), reading zero, and by an ammeter in the corresponding circuit of the secondary (Fig. 3), reading a minimum value. In the latter case the reading would not become zero, because of the existence of the magnetizing current $I\mu$. Perhaps a better illustration would be shown by a wattmeter connected to measure secondary output. If connected to read positive for points above b it would read zero at b, and would reverse for a point below b. Reversing the pressure coil it would again read positive for loads approaching a balance, the indication increasing until, at balanced load, the reading would equal half the total core loss of the apparatus. The wattmeter experiment is somewhat difficult to perform, because of the small quantities involved, and an old-time high core-loss transformer is more suitable for the purpose than a modern one.

The comparison of the two classes of

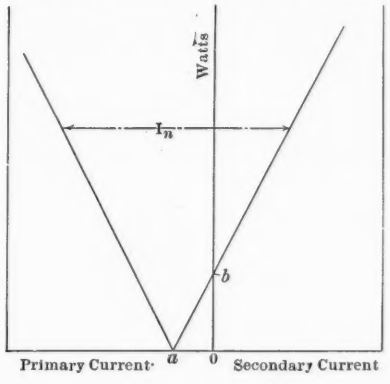


FIG. 4.—GRAPHIC REPRESENTATION OF AUTOTRANSFORMER BALANCER.

apparatus must cease with non-inductive loads or it will lose its instructive value. The autotransformer, and likewise the transformer, are interesting studies when applied to three-wire systems with loads of unequal power-factor. For instance, it is possible to have equal currents in the mains and a neutral current, not only greater than zero, but in excess of the main current. These problems will not be pursued to a conclusion in the present article; they are merely cited to show that it is not wise to cling religiously to analogies, and to emphasize again that the present comparison is confined to non-inductive loads.

[1] The primary and secondary load currents are opposed magnetically but in phase in the neutral wire, as may be seen by assuming instantaneous values of electrical pressure, preferably of the same polarity as shown for the direct-current analogue.

Municipal Ownership in Chicago.

Mayor Dunne, of Chicago, Ill., is quoted in the *Wall Street Journal* (New York, N. Y.), Tuesday, March 6, as follows:

"Municipal ownership stands a better chance here to-day than it did a year ago. The vote in favor of it on April 3 will be as large as it was last spring of two and one-half to one.

"The municipal ownership sentiment is spreading rapidly in the larger cities like Denver and Cincinnati. I frequently receive letters from leading college professors and mayors of cities endorsing my views, men like Professor Week, of the Northwestern University, and Mayor Weaver, of Philadelphia.

"In Chicago there are 150 miles of street railway, including the Washington street tunnel, without franchises. Should the supreme court decide the 99-year act in our favor there would be 120 miles more at our disposal out of the total surface mileage of 700. Even though the companies win there will still be 274 miles covered by expired franchises by January 1, 1908, and this mileage serves 1,100,000 out of our 2,000,000 population, being in the center of the city.

"I do not care to say what I think we ought to pay the present owners for their property when we take it over, but I know we could build an entirely new and larger system, fully equipped, with $75,000,000 we propose to raise by the sale of Mueller certificates. We asked the companies to name a price but they declined to negotiate.

"Should the Union Traction and City Railway lines be consolidated it might make our negotiations all the easier, as we would have to deal with only one party. Elevated lines are not concerned.

"The Mueller certificates at five per cent should bring par. We may sell them to a syndicate of bankers or we may sell them to the contractors in parcels as the lines are built. These certificates would represent a first lien and a perpetual franchise. They should sell at least as high as the bonds of the present companies under franchise of twenty years or less.

"Though an outside company be formed to operate the lines it will be under the jurisdiction of the city and with civil service there will be no politics in the administration."

Uranium Ore Available.

Consul Ledoux reports from Prague that uranium ore can now be secured from the Austrian government mines of Joachimsthal, Bohemia. For post parcels the cost is $3.32 per pound; in larger shipments according to the assay, 50 per cent ore at $2.22, and 60 per cent ore at $2.66 per pound. The Austrian authorities inform Mr. Ledoux that the residue, pitchblende, is not available for sale.

Consul Ledoux also advises that the historical wolfram-tin-ore mines in northern Bohemia have been reopened by the Schönfeld-Schlaggenwalder - Wolfram - Zinnersgruben Gewerschaft, who may need mining machinery.

Municipal Arc Lighting from Steam Turbine Power.

The City Plant at Columbus, Ohio.

THE steam turbine has had many and varied applications in the electric light and power field, but among the more recent and exclusive applications is that of street lighting by alternating currents. A good example is to be found in the modern and well-equipped power station operated by the city of Columbus under the special supervision of the Board of Public Service. The plant has been in service since the close of 1904, but only within six months has the full quota of lamps been connected to the distribution system. The load upon the station is due to arc lighting alone and is practically constant during lighting hours. With its equipment of steam turbines, surface condensers, superheaters, mechanical stokers and other labor-savers, the plant has shown, as was expected, very low operating costs considering the low load factor and the class of service.

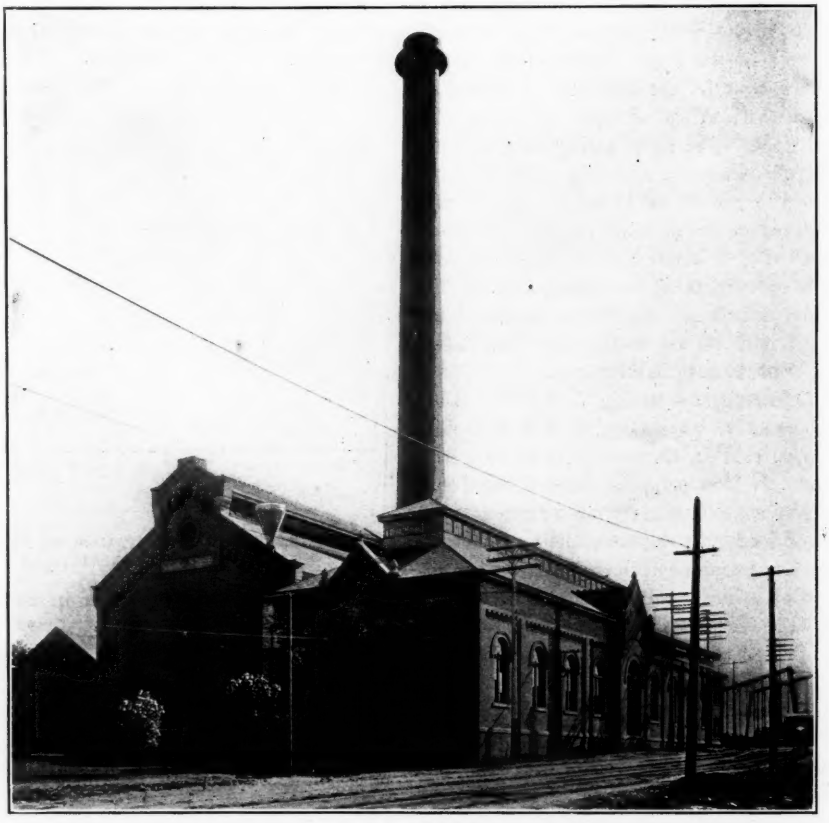
Close to the city pumping station, in the western section of the city, is located the municipal lighting station. Erected by the city solely for the purpose of supplying street arc lights, no incandescent lighting or power service has been attempted. Several features of design and operation merit special attention, and as most of the equipment is standard apparatus, these features will be mainly dwelt upon.

In brief, the power system consists of a sixty-cycle, three-phase alternating-current supply from a steam-turbine-driven generating plant. This current is delivered to the switchboard at a pressure of 220 volts, stepped up to a pressure of 6,600 volts for transmission and delivered to the various arc circuits through the medium of automatic constant-current transformers or choke coils. Constant-current series, alternating-current enclosed-type arc lamps are used exclusively on the various circuits, and at the switchboard the load of these several circuits may be transferred from one phase to another, in order to maintain an approximately balanced load. Lighting is based upon the all-night schedule (Fig. 1). An impressive feature of the system is its flexibility, absence of complication and the ease with which the load on the power plant is carried in such a manner as to obtain the highest efficiency.

The plant is housed in a handsome and spacious building. On the exterior the walls are of light-brown hard-pressed brick with sandstone trimmings and water tables; the interior is decorated with a wainscoting of white glazed brick. A monitor running the entire length of the engine room with swinging windows on either side provides ample ventilation. The condensing equipment for each turbine unit is contained in an open rectangular pit, lined with white glazed brick for appearance and better illumination. From an elevated gallery supporting the switchboard the electrician has full command of the entire generating and distributing equipment.

In the boiler room a steel coal bunker parallels the boiler fronts, supported independently of the walls and boiler settings. A brick chimney rises from the centre of the boiler room, midway between the present and future batteries of boilers. At present only about half the capacity of the station is installed, there being room for 1,000-kilowatt generating, and 1,800 horse-power additional boiler capacity. The ratio between the boiler and engine horse-power is about fifty-five per cent. With the present-sized units each turbine equipment with condenser, auxiliaries and switchboard occupies but two and one-half square feet per kilowatt capacity. The entire turbine room averages three and one-quarter square feet per kilowatt, boiler room 4.15 square feet per kilowatt, or total power-house seven and one-half square feet per kilowatt.

The record of performance of the Columbus station bears witness to the general effectiveness of the steam turbine as a prime mover. In no way has this been more apparent than in the excellence of its every day operation. Through periods of frequent loss of vacuum, excessive superheat, charges of water in the steam and reduced steam pressure (experienced in the early days of the plant), the turbines have maintained their load without difficulty or serious deterioration. The ease with which the generating plant is operated by two men is good evidence of its excellent service.



EXTERIOR OF LIGHTING STATION, COLUMBUS MUNICIPAL LIGHTING PLANT.

As usual with the Westinghouse-Par-

sons type, each turbine is fitted with a secondary valve which comes into use in case of loss of vacuum. The several units are brought into synchronism and operate in parallel through a simple governor adjustment. An independent oiling system for each unit is employed, driven by the turbine itself, so that loss of oil through failure of auxiliaries becomes an impossibility. This oil is circulated under a few pounds pressure through the bearings, cooled, and returned to the oil reservoir for a repetition of the same cycle. The very small amount of oil actually required is well indicated by the fact that in other turbine equipments of this type a single charge of oil undergoes complete renewal only after three to six months' service. Here, a cheaper grade of oil is used, and after two or three weeks' service is drawn off, filtered and made use of in the low-speed machinery.

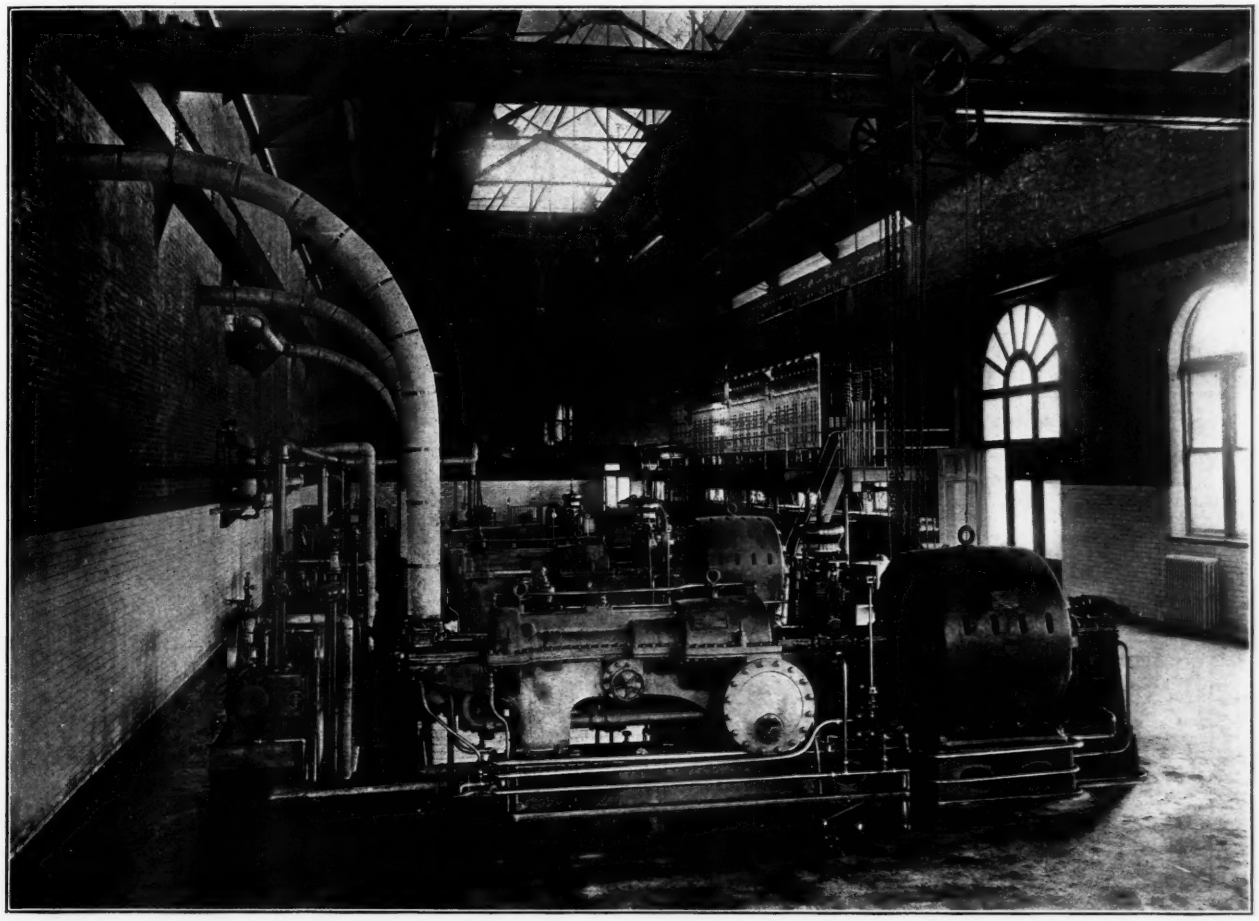
As an important factor in plant economy, a high-vacuum condensing system has been installed of Worthington construction. Independent circulating, hot-well and dry-air pumps are used, the first motor-driven and the others steam-driven. Liberal condensing surface has been proportioned to the turbines with a view of obtaining the highest possible vacuum. That the handling of water for this condensing service is not such an expensive matter as is generally believed is well shown by the fact that the circulating pump motor is but twenty horse-power capacity, or three per cent of the turbine rating. These motors, however, operate considerably under full load, and, in fact, the pump suction is ordinarily throttled by a gate valve in the suction line so as to reduce the amount of circulating water handled.

During the summer months the Olentangy river, which is depended upon for circulating water, runs low, necessitating running non-condensing, but the city is now completing a dam across the river in the rear of the power-house which will ensure ample storage to tide over between periods of normal rainfall.

To the equipment of mechanical appliances may be attributed a good share of the low cost of operation of the plant. Fuel is elevated to the bunkers and distributed to the stoker hoppers by conveyer and gravity, no hand labor being ordinarily required for this work. All boiler auxiliaries are steam-driven, their exhaust being conserved for heating the boiler-feed water. An economizer is also installed to reclaim part of the waste heat of the flue gases. This is by-passed by suitable dampers when desired. Roney mechanical stokers serve the entire boiler plant, taking coal from individual chutes and delivering ashes to inclined ash pits communicating with an ash tunnel beneath the floor.

As a check upon coal consumption and to indicate the general plant economy, the usual method of weighing the entire car is departed from, and separate weighing hoppers are assigned to each boiler, inserted in each bunker discharge. With this arrangement each charge of coal delivered to the stoker hoppers is weighed and recorded. This method has the advantage that the coal used is charged against the plant only when it is required, and weights recorded are independent of bunker capacity or other coal storage. The duty of the plant from day to day, or even for a part of a day's run, may thus be more accurately determined.

Superheated steam forms an important feature of the plant, and a separate steam



INTERIOR OF STATION, LOOKING TOWARD SWITCHBOARD. DRY-AIR PUMPS ON THE LEFT. COLUMBUS MUNICIPAL PLANT.

main with separate pipe connections is provided. The superheaters are of the usual internal multiple coil type suspended longitudinally beneath the drums of the Babcock & Wilcox boilers. They may be flooded in the usual manner if desired. Long radius pipe bends provide the necessary flexibility between boilers, steam mains and turbines.

Although provision for an independent supply of either saturated or superheated steam for the turbine has been made, it is also possible to so combine the output of the several boilers as to reduce the superheat to any desired extent. For this purpose the two mains are cross-connected at the ends of the run. In the normal operation of the plant, however, all superheaters are used, and the saturated steam main serves only the plant auxiliaries. The weight of the steam mains with their adjacent piping is borne by steel wall brackets provided with single pipe rollers to accommodate linear expansion and contraction. A non-return valve in each boiler riser prevents back flow of steam in case of a ruptured tube.

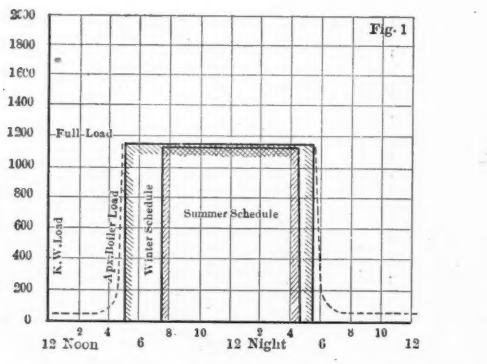
With the present equipment a superheat of from 100 degrees to 140 degrees is generally available at the turbine throttles, depending upon the load and pressure, averaging at normal pressure about 110 degrees. With care in the handling of fires it is not difficult to control the superheat and maintain it nearly constant. It is, however, more or less sensitive in this respect and requires watching to obtain the best results.

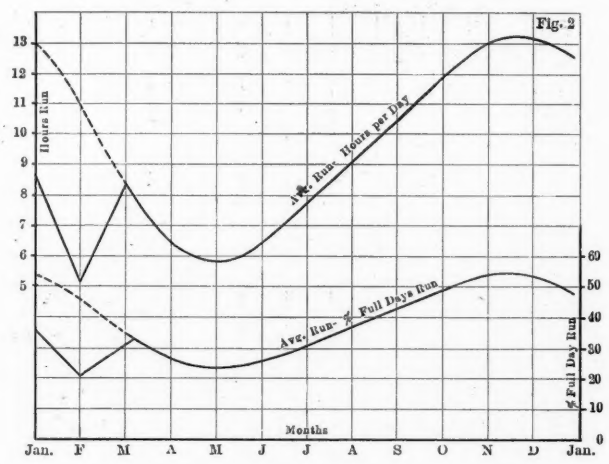
In the turbo-generators the standard revolving field Westinghouse construction is employed, with a duplicate equipment of engine-driven shunt-wound exciters. Oil switches control the generators, which are synchronized by the ordinary lamp method. Integrating wattmeters measure the output of the station, with indicating instruments for distributing the load on the several feeders.

In addition to the usual generator and load panels, the switchboard contains three six-panel feeder sections devoted to arc circuits. Each section is controlled by a "section" oil switch, so that in event of an accident to the board the trouble may be localized and not result in shutting down the entire station. Further, if it is desired to operate a portion of the lamps independently of the other, this may be done by shifting the load of this section to an auxiliary bus with which the main switchboard is equipped. By means of double-throw switches the load may then be thrown on a separate generator.

Each feeder is devoted to the control of one step-up transformer and arc regulator with the circuits thereon, and by means of switch connections a reserve transformer may be immediately cut into circuit in case of a transformer failure. All high-tension switching, transferring of circuits and balancing of loads are done with bayonet switch plug connections through which the safety of the attendant is assured.

Until about the middle of the preceding year the plant was not operating under normal and best conditions, owing to the lack of outside load, the temporary maintenance of a "dark night" schedule, uncovered piping and some troubles at first encountered in the condenser circulating water system. High economy could not, therefore, be expected. Operating on an average of but little more than one-third





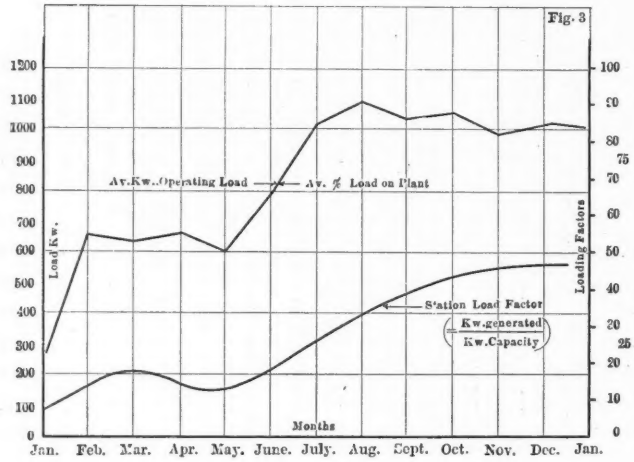
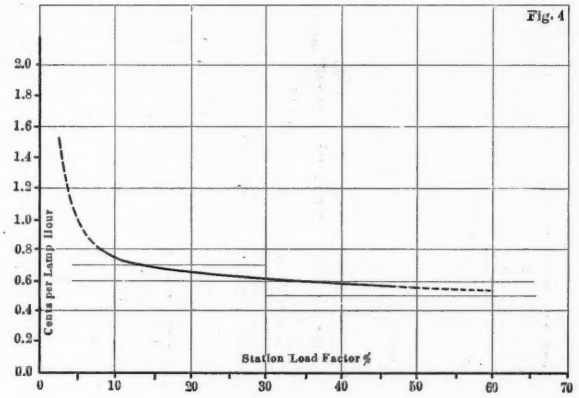


Fig. 3
Av. Kw. Operating Load
Av. % Load on Plant
Load Kw.
Loading Factors
Station Load Factor
Kw. generated / Kw. Capacity
Months
Jan. Feb. Mar. Apr. May. June. July. Aug. Sept. Oct. Nov. Dec. Jan.

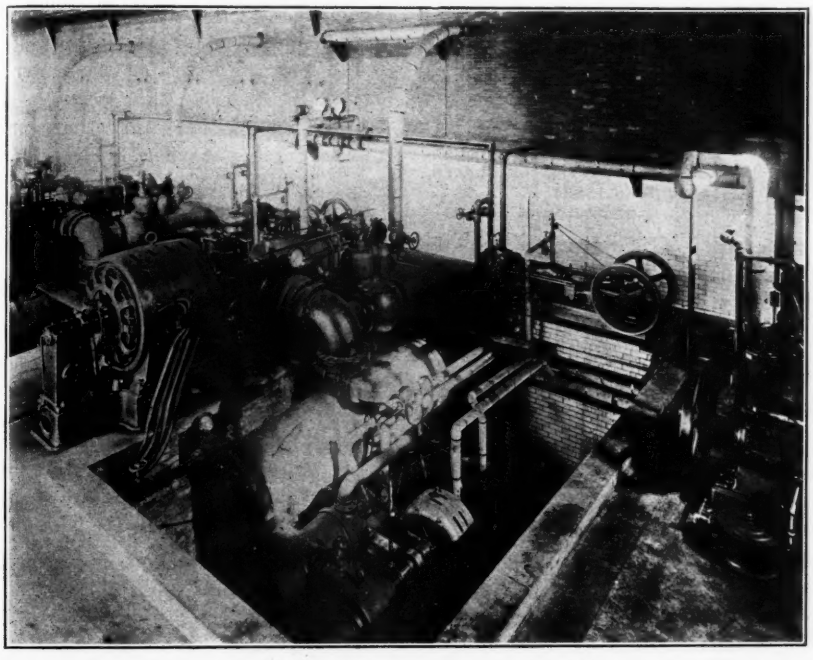


STATION CHARACTERISTICS—FIG. 1.—TYPICAL LOAD-CURVES. FIG. 2.—OPERATING SCHEDULE. FIG. 3.—PLANT LOADING. APPROXIMATE RELATION OF TOTAL OPERATING COST PER LAMP-HOUR TO STATION LOAD-FACTOR.

of the time (see Fig. 2), the standby losses during the day evidently constitute an important source of inefficiency. It must be remembered in connection with the load that although the load-factor is high during the winter months, practically fifty per cent of the boiler plant is entirely idle during the day, but must be brought up to its maximum capacity previous to starting. Thus the station necessarily wastes much heat in banked fires during the day and in building and quenching fires before and after the night's run. The accompanying charts show clearly the operative characteristics of the station: Fig 1—typical load-curves for different seasons; Fig. 2—the average run for different months of the year; Fig. 3 —the station load and corresponding loading factor, and Fig. 4—the variation in operating cost with station loading, as deduced from the year's operation. The regular station operating force consists of five men, three shifts of eight hours each; two men in the boiler room, two in the turbine room and one at the switchboard.

As evidence of the low cost of arc lighting by this system the following figures are of interest: During the year of 1905 the cost of operation of the plant on dark night schedule was approximately $34,500. Within this period the number of lamps connected was gradually increased to nearly 2,000. The average operating cost per arc is given as $22 per year. This cost includes all labor and supplies, also ordinary maintenance of the entire system, but no betterments, taxes, nor depreciation. The last is an extra charge at five per cent of the equipment cost of the plant ($474,000). Including nine per cent fixed charges (interest four per cent, depreciation five per cent), the total cost to the city is said to be $49.15 per arc for the year ending December 31, 1905.

In the execution of the Columbus municipal lighting project, directors, engineers and manufacturers have contributed joint effort towards its success. The building and general plant arrangement was worked out conjointly by the city architect and engineer under the direction of the Board of Public Service. Westinghouse, Church, Kerr & Co. was entrusted with the design of boiler piping and condensing plants. During the erection of the station and its subsequent operation, Mr. William Wilcox has been in immediate charge as superintendent of the Department of Public Lighting.



CONDENSER PIT, SHOWING WATER-CIRCULATING PUMPS, VAPOR COOLER, AND AIR PUMPS. COLUMBUS MUNICIPAL PLANT.

A New Rubber Country.

Consul-General Richard Guenther, of Frankfort, Germany, quotes the report of the foreign explorer, Harry Johnston, to the effect that the republic of Liberia in West Africa possesses an almost unlimited supply of rubber trees. In a lecture before a company which has received a concession for the production of rubber in Liberia, Johnston stated that an extraordinary amount of caoutchouc is to be found in Liberia and that it only awaits collection. He did not hesitate to say that within six years 2,500,000 cultivated rubber trees furnishing an excellent quality of rubber will be yielding sap. Another report states that at least 20,000 square miles are covered with dense rubber tree forests. It is also stated that various creepers are found there containing rubber, which heretofore have been unknown.

POWER REQUIRED BY MACHINE TOOLS, WITH SPECIAL REFERENCE TO INDIVIDUAL MOTOR DRIVE.[1]

BY G. M. CAMPBELL.

In machine tool work speed variation is essential, and in a machine driven by an individual motor part of the speed variation must be obtained in the motor itself if efficient speed control is required. The range of speed required in some machines may be quite limited, on account of the particular class of work for which the machine is used, and in such a case the full range of speed could be supplied by the motor. On the other hand, the speed variation required may be so great that it is impossible to supply it all by the motor.

Just what range of speed is required in the motor can not be definitely stated for all conditions. If a total speed range of six to one is required in a machine, it might be advisable under certain conditions to obtain this total range in the motor, but as a general rule the writer believes it would be advisable to use at least two runs of gears when the speed change required exceeds four to one, and that a somewhat better and more efficient design can be obtained when the speed change required in the motor is limited to about three to one.

The controller necessary to enable the speed change to be obtained in proper increments will vary according to the range required and the size of the increment. It is feasible to work to within ten per cent change of speed and consequently a ten per cent increment would be desirable. If ten per cent increments are used the number of points of the controller would be obtained from the formula:

1. 1^{n-2} = speed range in motor.

Where n is the number of points in controller, "off" point being counted as one point. This would give results as follows:

Speed Range.	Controller Points.
3	14
4	17
5	19
6	21

If the motor is a reversing one, then to this number of forward motion points must be added the required number of back motion points; usually one-third to one-half the number of forward, so it is seen that the controller would become unwieldy in size or the speed increment would have to be increased above ten per cent. In the Pittsburg and Lake Erie Railroad shops the speed increment was about ten

[1] Abstract of paper read before the mechanical section of the Engineers' Society of Western Pennsylvania, January 9.

per cent and the speed range required in the motor somewhat less than three to one, the necessary number of runs of gears being used to give the total range in the machine. The maximum number of runs used was four.

Other conditions being the same, the power taken by a machine, after allowance is made for friction losses, will vary approximately as the speed and cut and therefore as the weight of metal removed, consequently in fitting motors to tools due allowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high-speed tool steels and the increase in rigidity of machines. A formula for the amount of power absorbed in cutting may be stated thus:

$$HP = KW$$

where HP = Horse power
K = A constant, depending on the kind and grade of material.
W = Weight of metal, pounds removed per minute.

Values of K may be taken as follows:

K = 2.5 for hard steel.
= 2.0 for wrought iron.
= 1.8 for soft steel.
= 1.4 for cast iron.

This formula is simply a general one, the power required in any particular case will vary perhaps 100 per cent according to the condition of the cutting tool.

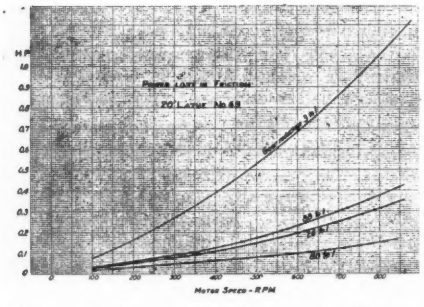


FIG. 1.—POWER LOST IN FRICTION, TWENTY-INCH LATHE.

Another factor which enters into the capacity of the motor required is the friction loss of the machine itself, this is a factor impossible to predetermine, but fortunately is not very large except on very large machines; it depends greatly on the gear reduction. The accompanying diagram, Fig. 1, gives a typical example of friction losses and shows the general run of such losses; the power lost in other machines may be assumed by comparison. It is for a twenty-inch by eleven-foot Putnam lathe, gear reduction varying from 3-1 to 80-1. The maximum loss is about 1.2 horse-power. The loss in friction is not directly proportional either to motor speed or spindle speed.

Fig. 2 shows the power lost in a sixty-inch planer, Fig. 3 in a punch, Figs. 6, 7 and 8 in some wood-working tools.

These curves show that the losses are small, except when the spindle or table is running at top speed. At the high-

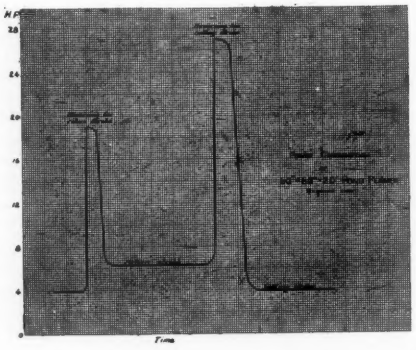


FIG. 2.—POWER CONSUMPTION OF PLANER RUNNING LIGHT.

spindle speed it is rather unlikely that a maximum cut is to be taken, but in all probability only light finishing cuts or polishing, so that in general the power lost in friction in the machine may be neglected in considering the question of size of motor required.

There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take, this is the reciprocating tool, as the shaper and planer and to a somewhat less extent the intermittent working machines, such as punches and shears. In planers where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives where motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it is of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a flywheel of large diameter and heavy rim so as to aid the motor at moment of reversal.

Fig. 2 is for a sixty-inch by sixty-inch by twenty-foot Pond planer. The cycle of power consumption is rather remarkable, but is a fair example of tools of this class and method of drive, reversal by shifting belts. These readings were taken with the machine running light. During cutting stroke the horse-power taken was 3.9, reversing to return stroke the power jumped to nineteen; on the return stroke it was 6.3 and in reversing to cutting stroke it rose to twenty-seven. Speed of the table in cutting stroke about twenty-five feet per minute; on the reverse stroke, sixty feet per minute. This planer was driven by a compound-wound Crocker-Wheeler motor, 73.5 amperes, twenty horse-power at full speed and voltage rating. The flywheel on this machine is much too small, but, owing to special design of the driving mechanism, it could not be increased. The driving mechanism would have to be improved considerably to make it suitable for much higher speeds.

Influence of design on the power required for punches and shears is well brought out by Fig. 3. The horse-power rose to twenty-one. The influence of the heavy flywheel and gear in another punch was sufficient to keep the power down to 7.9 horse-power on the same test.

In the shops of the Pittsburg & Lake Erie Railroad Company, at McKees Rocks, there are about eighty machines driven by individual motors. For variable speed work the speed variation required in the motor was, in general, about 2.8 to one for full power, but up to from six and seven and one-half to one for diminished power at low speeds, and the size of motor was approximately double the horse-power

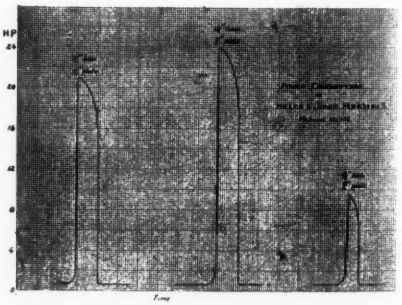


FIG. 3.—POWER CONSUMPTION OF PUNCH.

required by the machine throughout this full power range, *i. e.*, if the motor was rated as a variable-speed motor, it would have a rating approximately one-half that of the constant-speed rating. The speed variation in many instances differed considerably from the above. In many of the drills, the speed variation was higher and in planers, shapers, etc., lower. The speed control in these shops is obtained by means of the multivoltage system. The horse-power required by the machine was determined partly by general considerations and partly by the formula stated

above, H P = K W, where K had a value of 3.6 for hard steels and 2.5 for soft steels. From data given on previous pages, it may be seen that the size of this constant was on the safe side. All machines are protected by both circuit-breaker and

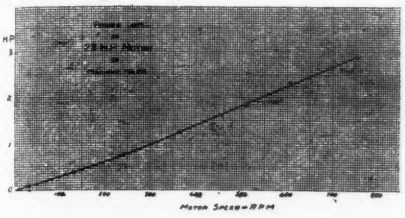


FIG. 4.—POWER LOST IN TWENTY-FIVE-HORSE-POWER MOTOR.

fuses, the size of the breaker was, in general, four amperes per rated horse-power of the motor and it was set at the limit of fifty per cent above this rating, the breaker would therefore fly out when the power consumption was approximately 100 per cent overload. On reciprocating tools, the circuit-breaker was set forty to fifty per cent higher. The enclosed fuses used had a rating the same as that at which the circuit-breakers were set.

After the plant was in operation a large number of tests was made, every machine listed being tested to see whether or not the motor capacity was sufficient. In no case is the motor too small. In a few cases the motor could easily be reduced.

In making tests three separate sets were made:

1. Power required to drive the motor disconnected entirely from the machine, the motor being run at all the speeds. (Fig. 4.)

2. Power required to drive the machine on its different gear drives and different motor speeds.

3. The total power required during the time the machine gear drives and different motor speeds.

This latter set of tests was taken haphazard, *i. e.*, the electrician simply passed from machine to machine and took readings and record of the cut, no attempt being made to get the record at the best tool efficiency, consequently the records give every day shop practice such as will probably be met with in the ordinary shop. Practically all the tests were made in 1904, not only after the new shops were running and consequently the cuts and speeds given are much lower than present-day practice, nor was any attempt made to make tests when the machines were taking heavy cuts. These points must be borne in mind if cuts and feeds are examined.

After the tests were made, the first set would be compared motor to motor to see if all motors were equally efficient, then the first set would be subtracted from the second to obtain friction losses in the various machines and finally the second set would be subtracted from the third to find the actual horse-power taken by the cutting tool or tools. The curve of power lost by friction is given for a typical case in Fig. 1. As a sample, however, of the tests made, table I is given for a seventy-two-inch boring mill. The horse-power given is the input into the motor, not the horse-power of the cut.

Table II is of some of the readings taken on a ninety-inch driving wheel lathe. After eliminating the power lost in friction and in the motor, the horse-power required to remove one pound of metal is given in Fig. 5, the amount varies from 3.87 to 1.70, certainly a very wide range, but the grade of steel also varies widely.

As to the power required by wood-working tools, the writer has formulated no general rules, a few sample power readings will be given to show the power required in certain machines. The power consumption in wood-working tools is very large, very much larger than one might ordinarily expect. In adapting these machines

TABLE II.—90-INCH DRIVING WHEEL LATHE NO. 23.

Motor: Type C. M., 25 H.-P. at 750 R. P. M., 230 V. 90.5 Amp.
R. P. M. of Spindle = 3.63, or 0.167% of Motor.

Motor					Cut.			Material.			Remarks.
Controller Point.	Voltage.	Current.	R. P. M.	H.-P. Input.	Feed Inches.	Depth Inches.	Speed Ft. per Min.	Dia. Inches.	Weight Pounds Min.	Kinds.	
16	188	60	637	15.1	3/16	3/16 & 3/16	13.0	48	3.1	Steel	Double Head.
13	157	50	430	10.5	3/16	5/16 & 5/16	8.8	48	3.5	"	" "
16	190	70	50	17.8	3/16	1/4 & 1/4	13.3	48	4.2	"	" "
13	156	45	540	9.4	3/16	3/16 & 3/16	10.9	48	2.6	"	" "
13	156	75	53	15.?	1/8	3/8 & 3/8	12.3	54	6.3	"	" "
13	156	70	536	14.6	1/8	3/8 & 3/8	12.3	54	6.3	"	" "
9	113	80	355	12.1	1/8	1/4 & 1/4	10.5	69	4.0	"	" "
9	114	77	363	11.8	1/8	1/4 & 1/4	10.6	69	3.6	"	" "
11	115	60	450	9.1	1/8	3/16 & 1/4	13.4	71	4.0	"	" "
17	196	46	728	12.1	1/8	1/4 & 1/4	15.5	51	5.3	"	" "

TABLE I.—72-INCH BORING MILL NO. 29.

Motor—Type C. M., 25 H.-P. at 750 R. P. M., 230 V. 90.5 Amp.
R. P. M. of Table=2.35, 0.97 or 0.34% of Motor.

Motor.					Cut.			Material.			Remarks.
Controller Point.	Voltage.	Current.	R. P. M.	H.-P. Input.	Feed. Inches.	Depth. Inches.	Speed. Ft. per Min.	Diam. Inches.	Weight. Pounds Min.	Kind.	
18	240	4	..	..	..	....	..	..	..	....	Running light, table not turning.
18	240	6	..	..	..	....	..	..	..	....	Running light, table turning.
18	..	20	785	..	.125	.125&.125	..	19.5	..	Cast Iron	Two heads.
21	233	28	970	8.76	..	....	..	..	..	....	Running light.
21	233	38	978	11.88	.0625	.094	47	7.5	0.99	Brass	
21	232	37	988	11.51	.0625	.0625	47	7.5	0.66	"	
4	76	38	243	3.77	.0625	.375	28	58	2.05	Cast Iron	
9	116	16	361	2.49	..	....	..	..	..	....	Running light.
8	76	49	340	4.98	.0625	.25	39	58	1.90	Cast Iron	
12	115	33	480	5.08	.125	.062&.031	44	44	1.24	Steel	
10	114	28	473	4.27	.125	.0625	42	44	1.11	"	
13	160	19	519	4.07	..	....	..	..	..	....	Running light.
9	113	75	354	11.36	.125	.125&.125	51	52	5.41	Steel	
9	112	95	249	14.26	.125	.187&.187	48	52	7.65	"	
9	115	58	360	8.93	.125	.125&.187	47	52	3.75	"	
17	195	25	684	6.54	.125	.125	80	19	4.50	Brass	
21	234	35	964	11.00	.125	.094&.031	123	20	6.91	"	
20	235	30	915	9.47	.187	.031&.016	115	20	3.64	"	
20	236	20	930	6.33	..	....	..	..	..	....	Running light.
20	244	13	940	4.25	.083	.125	33	18	1.07	Cast Iron	
6	78	26	294	2.72	.083	.125	33	18	1.07	"	
15	161	15	612	3.24	.062	.062	24	20	1.29	"	

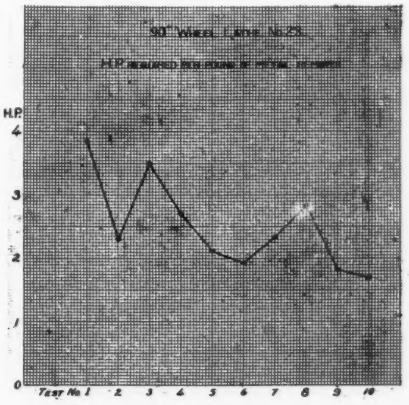


FIG. 5.—HORSE-POWER REQUIRED PER POUND OF METAL REMOVED, NINETY-INCH LATHE.

for motor drive, the motor should have ample capacity when the machine is to be used continuously in a manufacturing shop.

Table III shows the power taken by an eighteen-inch by thirty-inch Berlin planer.

The total power lost in the motors and lost in friction in the machines is considerable, even though in individual cases it is not very large. To investigate this point, among others, some experiments were made on a Sunday when the shops were idle. Forty-six machines were selected, every one equipped with an individual motor capable of speed variation. The machines were as follows:

Machines.	Horse Power Rating of Motors.
17 lathes	215
5 milling machines and boring mills	70
5 planers	66
5 slotters and shapers	35
9 drilling machines	50
5 punches, shapers, rolls, etc.	61
46	497

First, full-current strength was put on all the fields, then all the motors were run on the forty-volt circuit, then all on the eighty-volt circuit, 120-volt, 160-volt, 200-volt and 240-volt in turn, and finally lathes and drills were run on the high-speed point, approximately thirty per cent above normal 240-volt speed, power consumption being noted at all the different points. All machines driven by these motors were in motion, but no work was being done, nor was feed mechanism in use. The results are plotted in Fig. 9; planer platens were not operating except for points 3, 6 and 8. The curve giving losses in motor armatures was platted from readings on a number of motors disconnected from machines. The speed of the motors varies approximately as the impressed voltage, so it will be seen that after deducting 15.2 horse-power for the fields the horse-power lost in the motor-arma-

TABLE III.—18-INCH BY 30-INCH WOOD-WORKING PLANER.

Motor.—Type C. C. M. 60 H.-P. at 830 R. P. M. 230 V. 216 Amp.

Motor.				Cut.					Remarks.
Voltage.	Current.	R. P. M.	H.-P. Input.	Width. Inches.	Depth. Inches.	Feed. Ft. per Min.	No. of Heads.	Kind of Wood	
244	60	892	19.6	.....	....	....	....	....	Planer running lt.
233	85	833	26.6	11	0.25	50	2	Oak	
232	95	839	29.5	11	0.25	50	2	"	
231	110	830	34.1	22	0.25	50	2	"	Planing two.
231	110	826	34.1	16	0.25	50	2	"	" "
230	130	822	40.2	24	0.25	49	2	"	" three.
241	100	868	32.3	16	0.25	52	2	"	
239	150	828	48.0	12 + 12	0.75 & 0.25	50	2	"	Hand feed.
238	160	834	51.0	12 + 12	1.25 & 0.25	50	2	.....	" "
240	140	840	45.0	10 + 10	1.75 & 0.25	50	2	.....	" "

Fig. 6 gives the power required to drive an eight-inch by twenty-four-inch Fay planer reducing a six and one-half to six and three-quarter-inch by twelve-inch and a six and three-quarter to seven inch by twelve-inch oak beam to six inches by twelve inches. Power required starting machine was about twenty-five horse-power, running light, 5.7 horse-power. The power under cut includes the power loss running light. Readings were taken about fifteen seconds apart.

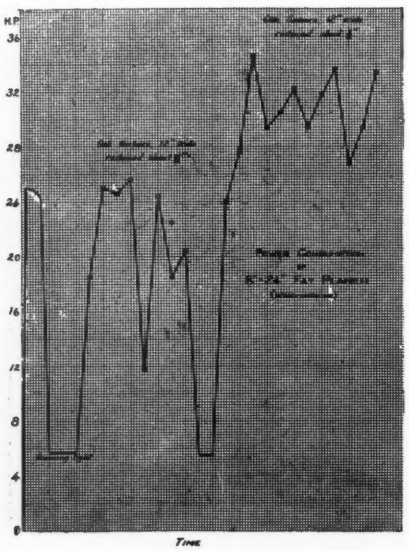


FIG. 6.—POWER CONSUMPTION OF PLANER.

Fig. 7 is for a thirty-two-inch cross-cut saw, sawing eight-inch by twelve-inch oak beams.

Fig. 8 is for thirty-inch rip saw, first part taking cut six inches deep in dry oak, second part eight inches deep in very wet oak.

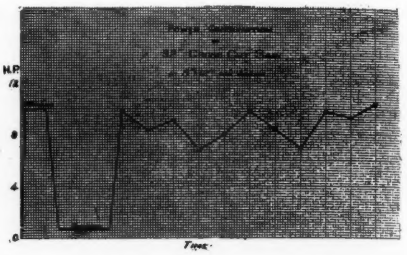


FIG. 7.—POWER CONSUMPTION OF CROSS-CUT SAW.

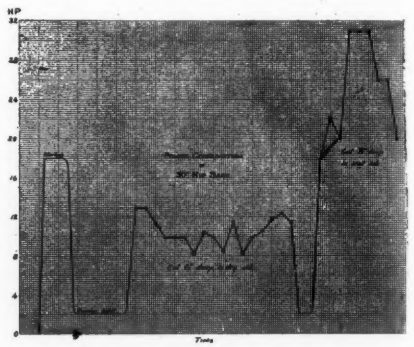


FIG. 8.—POWER CONSUMPTION OF RIP SAW.

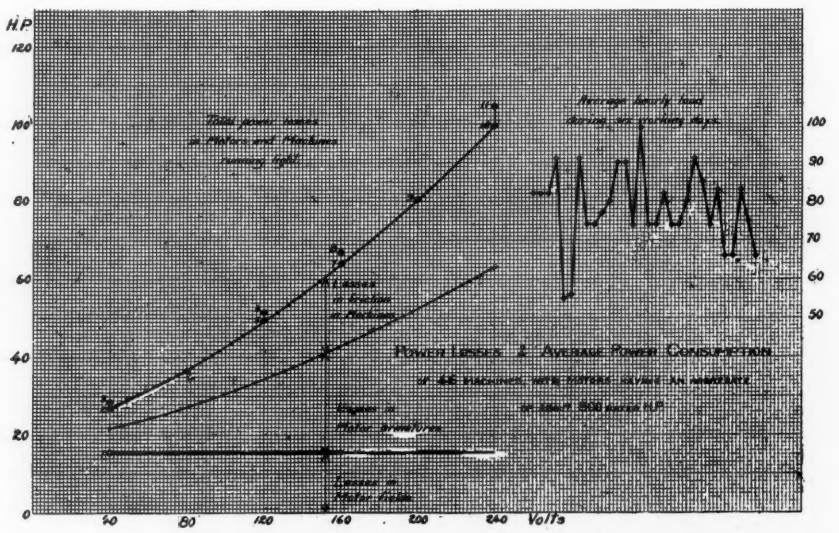


FIG. 9.—POWER LOSSES AND AVERAGE POWER CONSUMPTION OF FORTY-SIX MACHINES, WITH MOTORS HAVING AN AGGREGATE OF 500 RATED HORSE-POWER.

ture and tool varies approximately as the speed. It will be noted that when all these forty-six tools were running at top speed, no useful work being done, the lost horse-power was 105. The full losses given are never incurred as the tools are never all running at one time and never all on the top motor speed, in fact the average or even the maximum power consumption on any working day when all the tools are working is less than the maximum for lost power alone. The part of curve at the right hand in the figure is the total power consumption for all the tools included above and a few constant speed motors besides. These readings were taken every two hours during the six working days succeeding the Sunday on which the readings for power losses were taken.

A large number of special conditions may enter into the determination of the size of the motor required for any particular tool, the class of work it is to be restricted to, the grade of material, whether cuts, if heavy, will be of short duration, etc., so that it is rather difficult to make a statement that will fit all cases, but the writer would suggest the following for determining size of motor for average conditions—assume a cutting speed of fifty to seventy feet a minute for soft steels, estimate the maximum size of cut that will likely be required for any time longer than thirty minutes, transfer this into pounds of metal removed per minute and multiply by 2.7 (this figure is fifty per cent above the constant 1.8 used previously in this paper, the increase being for safety for bad conditions), then select a motor which will develop this power throughout the range of speed desired.

The record is not quite complete as it does not give the gear reductions in use, some of machines were using high-speed, some low-speed gears. If all the machines had been run on the highest speed gear the loss in friction in the machines would probably have been doubled.

Chicago to be Connected with Long-Distance Independent Telephone System.

A daily newspaper despatch states that within sixty days Chicago will be in connection with the independent telephone system of the United States, according to Albert G. Wheeler, president of the Illinois Tunnel Company.

Final plans for connecting the independent companies of Indiana with the automatic telephone system of Chicago were made by Mr. Wheeler and President Theodore Thorward, of the South Bend Telephone Company. The Indiana concern will extend its lines to South Chicago and from that point the tunnel company will take up the extension work.

GAS ENGINES AS APPLIED TO ELECTRIC DRIVING.[1]

BY JAMES ATKINSON.

It is of great interest to realize how economically electric current can be generated when producer gas is used. As a typical instance the following particulars of three sets of engines with suction gas plants will be of interest: each complete unit consisted of a gas-producer in which common coke was burnt, two coke-filled scrubbers, a motor-driven rotary tar separator, a sawdust scrubber and the engine directly coupled to a direct-current Crompton dynamo. The three units were tested on a six hours' run, one of such tests giving the following results: total fuel consumed 488 pounds, total kilowatt-hours 368.4, fuel per hour 81.3 pounds, kilowatt-hours 61.4, fuel per kilowatt-hour 1.325, fuel per brake-horse-power per hour 0.92 pound, thermal efficiency of the entire plant 22.75 per cent, proportion of total heat in the fuel converted into electric current on the switchboard 20.87 per cent.

An investigation as to the amount of irregularity in the turning moment will show what is permissible in a single-cylinder "Otto" type engine, directly coupled to a continuous-current dynamo, giving steady lights and sufficient regularity to run two or more units in parallel. In Fig. 1 a diagram taken from such an engine is shown, also the effect of the inertia of the reciprocating parts expressed as pounds per square inch on the piston. In addition a third line is given, showing the combined effect of the compression and the inertia of the reciprocating parts. Fig. 2 gives the full impulse diagram corrected for inertia of reciprocating parts, illustrating the amount of work developed during a working stroke, together with the rate at which such work is developed. Fig. 3 shows the turning moment on the crank pin during the complete cycle. If we assume that work is being done by the engine at a constant rate, and include friction, which also may be regarded as being a constant resistance, the dotted line on Fig. 3 drawn above zero line represents the mean rate at which work is being done, and from this diagram the exact speed rate of the flywheel at any portion of the cycle can be ascertained. For the present purpose it will, however, be sufficient to ascertain the maximum and minimum speeds of the flywheel and percentage variation.

Let us assume the diameter of cylinder to be eighteen inches, stroke two feet, revolutions 200 per minute and energy stored up in flywheel and revolving parts 720 foot-tons. In Fig. 3 the amount of acceleration due to excess work is represented by the shaded portion. On calculating this excess it works out to 21.524 foot-tons, therefore we have 741.524 foot-tons stored-up energy at *c;* as a maximum the speed of the flywheel will be in the ratio of the square roots of these stored-up energies, and the flywheel at *c* will be moving at the rate of 1.492 per cent faster than it is at the point *b;* from the point *c,* of course, the flywheel begins to slow

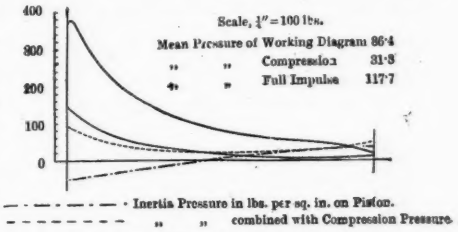


FIG. 1.—SINGLE-CYLINDER ENGINE.

down. At the time of the next ignition it will be at its original rate of 200 revolutions per minute. Should the engine be governed by "hit-and-miss" governing, and an impulse cut out, it would fall below 200 revolutions per minute by an amount corresponding to the loss of one impulse; this amount is 19.635 foot-tons. The stored-up energy in the flywheel would drop from 720 to 700.365, representing a decrease in speed of 1.406 per cent. The 1.492 per cent is what is commonly known as cyclical variation, and the 1.406 per cent as governing variation, the cyclical

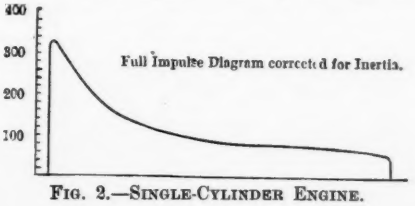


FIG. 2.—SINGLE-CYLINDER ENGINE.

and governing variation thus together amounting to 2.898 per cent.

Extensive experience with a great number of installations has shown that this degree of irregularity is permissible. The simplicity of "hit-and-miss" governing, together with the economical results thereby attained, make such an arrangement thoroughly satisfactory in many instances. There are cases, however, where automatic regulation has been introduced with a view to eliminating the governing variation. Broadly speaking, four methods have been adopted for this purpose: (1) throttle governing; (2) cut-off governing; (3) varying the richness of the charge by throt-

[1] Abstract of a paper read before the Manchester section of the Institution of Electrical Engineers of Great Britain, February 13.

tling the gas; (4) varying the richness of the charge by admitting the gas earlier or later during the suction stroke, but cutting it off always at the same period at the end of the suction stroke. The writer proposes briefly to give his views as to the relative merits and demerits of these various methods.

Governing by Throttling a Uniform Mixture—This method has been adopted by the Westinghouse company, by many of the Continental firms, and by other makers in England. The principal objections to this method of governing are the increase in gas consumption as the load decreases, also, there is a considerable resistance during the suction stroke, causing a good deal of negative work; the reduced pressure at the end of the compression stroke interferes with prompt ignitions, and in some instances leads to reversal of stresses in the moving parts owing to reduced compression.

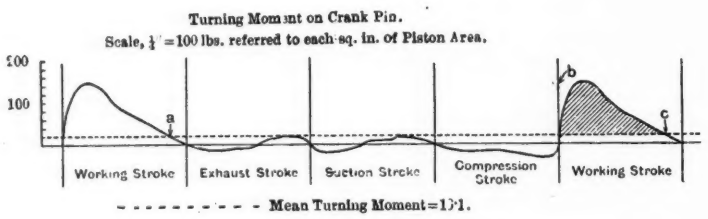


FIG. 3.—SINGLE-CYLINDER ENGINE.

Cut-Off Governing—This has been very largely adopted on the Continent. In the case of larger engines "trip" gears are used, very similar in construction to those used in steam engines. Governing by this method has been very satisfactory so long as the speeds of the engines were moderate. It is, however, not suitable for engines running at high speeds. Compared with throttle governing there is very little loss from negative work; it also lends itself to combining the cut-off with "hit-and-miss" governing—that is to say, if the engine is working on heavy or medium loads the regulation is entirely by means of cut-off, but on lighter loads the governor can allow the gas valve to remain closed, so that the regulation is partly by small charges and partly by cutout impulses, thus avoiding the very heavy consumption on light loads. For charges down to half load, although the charge is ignited at a lower compression pressure, still it expands to a very much lower terminal pressure, and from experiments which the writer has made, the economy with such governing is quite as good as with ordinary "hit-and-miss" governing. When running on or below a half load a little consideration will show that this irregularity of turning moment, with occasional cutout charges, is no greater than it would be at full load without any misignitions, the stored-up energy in the flywheel being proportionally greater than the impulses and the load for the time being. This style of governing is open to the objection mentioned in connection with throttle governing, the reduced compression pressure under some circumstances not being sufficient to take up the inertia of the reciprocating parts.

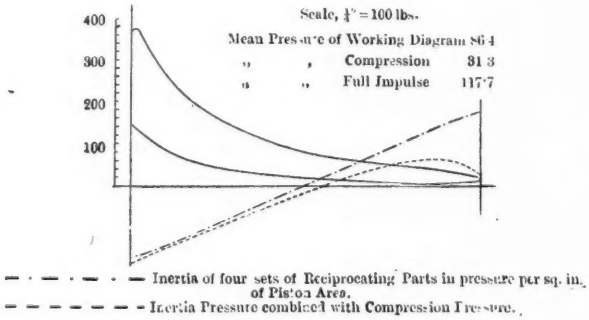

Scale, ¼" = 100 lbs.
Mean Pressure of Working Diagram 86·4
" " Compression 31·3
" " Full Impulse 117·7
400
300
200
100
Inertia of four sets of Reciprocating Parts in pressure per sq. in. of Piston Area.
Inertia Pressure combined with Compression Pressure.

FIG. 4.—FOUR-CYLINDER ENGINE.

Governing by Varying the Richness of the Mixture—This method can scarcely be said to be generally used in practice. The amount to which the richness of the mixture of the charge in a gas-engine cylinder may be varied is somewhat limited, if the gas is to be economically consumed. If either too rich or too weak, the gas is not properly burnt, and there is considerable risk of irregularities in the working of the engine, causing bangings or ignitions at improper times, sometimes in the admission pipes and sometimes in the exhaust pipes.

It would appear that such irregularities, combined with the somewhat narrow range of governing, are sufficient to prevent this method of governing from being largely adopted.

Varying the Timing of the Admission of the Gas, But Always Cutting It Off at the End of the Stroke at the Same Time—This method is being largely adopted on the Continent, and is the revival of an old method of governing introduced originally by the late Mr. Frank Crossley in the very early days of electric driving by means of gas engines. This method also has the advantage of not decreasing the compression pressure. In this connection there is a very great difference between the older arrangement referred to above and the newer methods. In the old arrangements the compression pressure was about forty-five pounds per square inch, whereas in the present type of engines the compression pressure would probably be in the neighborhood of 150, or perhaps more. The particles of gas and air are more nearly brought together, and the heat due to compression is so high as to bring the charge at the time of ignition to closely approaching ignition temperature, with the result that the gas is more thoroughly burnt, and there is no reason to suppose that this method of governing will be uneconomical.

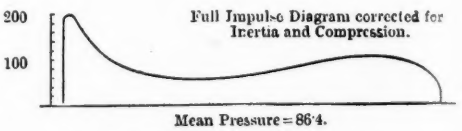


FIG. 5.—FOUR-CYLINDER ENGINE.

The driving of alternating-current dynamos in parallel is an altogether different problem. The writer frequently has to deal with enquiries relating to engines for driving alternators, and would like electricians to note that the steadiness of rotation necessary for driving alternators differs most materially from the kind of steadiness required for driving continuous-current machines. In almost every instance enquiries and specifications for engines to drive alternators state that the variation in speed of the engine must not exceed some particular fraction of the mean speed, varying from one one-hundred and fiftieth to much smaller fractions, or ask what degree of regularity would be guaranteed. He begs to submit for

their consideration that this is a wrong method of defining the necessary steadiness of such an engine. The required regularity is a function of the angularity difference between, say, the flywheel of the engine and a flywheel running at absolutely constant speed. This angular variation is certainly due to speed variation, but it is speed variation qualified by a time element.

It is pretty well understood that for alternating machine driving a multiple-cylinder engine will be used. After going carefully into the best arrangement for such engines, it is clear that engines giving two impulses per revolution will be mainly adopted for moderate powers, and for larger powers two such engines would be combined having their cranks at right angles. It will be of interest to show the degree of regularity which can be obtained by such engines. For the sake of comparison the same diagram has been taken as illustrated in Fig. 1, and curves have been plotted out showing what will

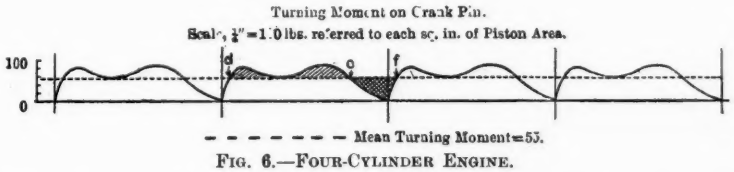


FIG. 6.—FOUR-CYLINDER ENGINE.

take place with a vertical four-cylinder "Otto" cycle engine. Fig. 4 shows the diagram, a line showing the inertia for four sets of reciprocating parts, and a line showing the inertia pressure combined with the compression. Fig. 5 shows the full impulse diagram corrected for inertia and compression, and Fig. 6 shows the turning moment on the crank pin; the dotted line being the mean turning moment. In this four-cylinder engine the size of cylinder is taken as before—viz., eighteen-inch diameter by a two-foot stroke, the revolutions being also 200, and the power of the engine, of course, being four times as great. The diagram shown in Fig. 6 shows what a remarkable effect the inertia of the four sets of reciprocating parts has upon the resulting turning moment on the crank pin, the shaded portion between *d* and *e* representing the excess of energy put into the flywheel, being such a small percentage of the work done during one impulse, the impulse giving as before 19,365 foot-tons, and the excess being 3.39 foot-tons; the deficiency from *e* to *f* of course being also 3.39 foot-tons, the increase in speed takes place from *d* to *e*, and decrease from *e* to *f*. Assuming that we have 610 foot-tons energy stored up in the revolving parts when running at 200 revolutions at the point *d*, excess energy to the extent of 3.39 foot-tons being added by the time *e* is reached, the speed at *e* would be increased in the ratio of the square roots of 610 to 613.39, which works out to 0.312 per cent. From an inspection of Fig. 6 it is evident that the flywheel compared with a wheel running with absolute regularity will be at its mean speed at a point between *d* and *e*, a little nearer to *e*, and again at a mean speed between *e* and *f*, a little nearer to *f*, changing from these positions approximately every ninety degrees. In passing from the mean-speed position to the most advanced position the flywheel is traveling at a speed varying between mean speed and maximum speed, which is 0.312 per cent faster, consequently its excess angular advance becomes about 0.14 degree.

With such a small deviation it is obvious that it is not necessary to go into intricate mathematical calculations to ascertain more closely what the actual deviation is, as no alternator can possibly require such regularity as one-seventh of one degree either way, and as it is impossible to get absolutely equal impulses in all the cylinders under all circumstances, it is necessary to provide for such contingencies, therefore in this instance these contingencies are the controlling elements in deciding on the required amount of stored-up energy, not the cyclical variations. The synchronizing efforts of the alternators themselves, of course, assist in keeping them in step, and thus still further counteracting any irregularity in the working of the engines.

Various arrangements have been made to enable two strokes per revolution to be obtained, and four-cylinder vertical engines on to four cranks seem as though they would be very suitable for engines up to moderate powers. For large powers horizontal cylinders promise to be the most convenient, either having four single-acting cylinders arranged on two cranks with the alternator on the shaft between them, or two double-acting cylinders on to one crank, and for still greater powers four double-acting cylinders on to two cranks at right angles.

Considerable care should be exercised as to the relative positions of the cranks, the flywheels and the alternators. If it can be arranged it is desirable to build up the armature of the alternator on the flywheel itself, or at any rate directly couple it to the flywheel, without passing the strain through separate keys on the shaft. Should there be four cranks, as in a vertical four-cylinder engine, it would seem desirable to use a similar arrangement, and only have one flywheel at the same end as the alternator. A considerable number of such engines have been made with a flywheel at each end, an arrangement which does not commend itself to the writer, as vibratory strains might be started up in the crank shaft itself, which under certain circumstances may be so serious as to cause fracture to the shaft.

It may be true that large steam-turbine installations have greatly interfered with the development of large gas engines for electric driving; it is well to bear in mind, however, that the steam turbine has taken considerably longer to bring to its present state of perfection than the large gas engine, which has only been developing during the last few years. Those only who are thoroughly conversant with the subject of large gas engines can estimate the serious difficulties which have been overcome, and appreciate the efforts which have been made in this direction; it is very satisfactory to realize the enormous strides and the solid advances which have been made. There is no doubt that great developments are taking place, and the increasing use of large gas engines is certain to continue. The writer has a very strong feeling that the gas turbine will ultimately be made a practical success, and should this be so it would hold a unique position as the motive power, at any rate for electric-current driving.

Experiments on the Propagation of Longitudinal Waves of Magnetic Flux along Iron Wires and Rods.

At a recent meeting of the Physical Society, of London, a paper dealing with experiments on the propagation of longitudinal waves of magnetic flux along iron wires and rods was presented by Professor Lyle and Mr. Baldwin.

The experiments described in the paper were undertaken with the object of determining if there is a definite rate of propagation of magnetism in iron. The method adopted was to produce magnetization at a particular point on a bar by means of a coil through which an alternating current was passed and then to observe the magnetic flux at various distances from the coil by means of a small secondary coil, free to be moved to various places on the bar. By the use of Professor Lyle's wave-tracer the magnetic flux at various points along the bar was thus obtainable. The wave curve was then analyzed by Fourier's series. Various curves given in the paper show the value of the constants in Fourier's series and of the lag in the magnetization as the coil was moved along the bar. Contrary to what had been observed in previous researches, the authors found that the phase lag, instead of continuously increasing along the bar, reached a maximum value and then diminished, proving the absence of true wave propagation.

Electrical Notes from Europe.

(By Our Special Correspondent.)

FOR some time past the Municipal Council, of Paris, has been considering the question of reorganizing the system of electric lighting for the city, as the contracts with the existing stations are soon to expire and some new arrangements must be made. Accordingly the council decided at a recent session that it would receive propositions relating to the future system of electric lighting for the city from the leading companies. These propositions are divided into two general classes. The first class relates to the establishment of a definite system and in the meantime providing a temporary system which will make the change more gradual from the old to the new plan. In this case the proposed method will have the choice of using the material which belongs at present to the companies which hold the concessions, or of adopting an entirely new outfit. In the second class of propositions a fixed and definite régime is to be adopted at once, without allowing for an intervening period. All these propositions are to be accompanied by a full set of plans and estimates and must contain all the needed technical information.

A new type of direct-current motor has lately been brought out in Germany by the firm of J. J. Rieter & Company, of Winterthür. It is intended to be used on narrow-gauge electric lines and will give about eighty horse-power. A voltage of 1,500 to 1,700 direct current is used for the line. The motor operates normally at 440 revolutions per minute. The armature has a resistance of 2.65 ohms at seventy degrees centigrade. It will run easily under a thirty per cent overload with a rise of sixty to seventy degrees centigrade. The total weight of the motor, including the case and the gearing, is about two tons. On the Bellinzona-Mesocco line in Italy it was found that four motors of the above type would easily take a train of seventy tons total weight. A voltage of 1,500 was used on the motor.

The Société Industrielle, of Amiens, France, has decided to award a number of prizes this year for specially meritorious inventions and devices in the mechanical or electrical field. The descriptions of the inventions or models of the same are to be sent in before July 1 to the address of the society, 29 rue de Noyon. Foreigners are allowed to compete, but the descriptions must be drawn up in French. One of the prizes relates to a simple device which will give a notable improvement in regard to apparatus for boiler security, such as the automatic closing of the furnace doors, steam-expansion traps and similar devices for affording security to the firemen. A gold medal is to be awarded for this and the following devices: second, a mechanical, chemical or thermic generator of electricity which will realize the best conditions of economy; third, an apparatus for suppressing or lessening the noise which is caused by steam blowers for boiler furnaces. It must take up but a small space and be easily mounted in place, and cheapness is another point to be considered; fourth, a new process which will prevent the harmful effects of material contained in boiler feed water, so as to be a decided improvement and need but little attention; fifth, a fuse block for lighting circuits which has a fusible metal capable of melting without forming an arc for a well-determined current, using end-pieces which are non-conductors of heat; sixth, a storage battery which is to be a decided improvement over the present forms; seventh, an incandescent lamp of superior qualities, working up to 250 volts. It must take less than 2.5 watts per candle-power and burn for at least 500 hours. Five lamps are to be submitted of each of the following types: five, ten and sixteen candle-power running on 225 volts.

We expect very shortly to give a full account of the large central station of St. Denis which is now being installed in the suburbs of Paris. In the meantime we may mention a few additional details as regards the steam-turbine groups of this important plant. The main dynamo room will be equipped with twelve principal turbine sets of the Brown-Boveri (Swiss) pattern. These machines form three groups of four units each, and there is a separate boiler plant for each unit. Three of the alternators in each group are designed to give three-phase current at 10,000 volts and twenty-five cycles for some of the substations of the Paris subway. The fourth alternator is a two-phase machine and delivers 12,000 volts at forty-two cycles. It is used for some of the city lighting mains. These machines give 6,000 kilowatts and run at 750 revolutions per minute. The steam is generated at a pressure of twelve atmospheres and is superheated to 300 degrees centigrade. Besides the principal turbine sets there will be a number of others which will give direct or alternating current, and some of them will act as rotary converters. One of these sets is a turbine of 400 horse-power and 2,700 revolutions per minute, coupled to a 230-volt direct-current generator for exciting the fields of the alternators at starting. There will be three groups of rotary converters giving 380 kilowatts each, consisting of a non-synchronous three-phase motor running on 10,000 volts coupled to a 230-volt direct-current generator. These groups are used for the regular exciters of the station, also for lighting and motors on the premises. One point to be noticed is that they will be worked in parallel with a storage battery of 126 cells and 500 ampere-hours on a 750-ampere rate, by means of a booster. A mixed group consists of a three-phase alternator using 10,000 volts and twenty-five cycles and a two-phase machine at 6,000 volts and forty-two cycles taken from the transformers, coupled on a common shaft with two direct-current generators of 750 kilowatts and 550 volts.

Among the large Swiss electric railroads may be mentioned the new Schleitheim-Schaffhouse line, which has a total length of twelve miles. The highest grades on the road are six per cent and there are some short curves. The difference of level is some 500 feet. The portions of the line which pass through the towns and villages use 500 volts, while in the suburban parts 700 volts are used. The trains run at a speed of twelve miles an hour. A trolley wire of eighty square millimetres is employed, supported on wood poles. The motor-cars have four axles and weigh twenty-two tons each. These cars are fitted with four Oerlikon direct-current motors of sixty-five horse-power each. A one-to-five reduction gearing connects a motor to each axle. A trailer weighing six tons is generally used with the motor-car. The central station at Schaffhouse supplies three-phase current at 10,000 volts and fifty cycles to the main substation of the road, which is placed about midway on the line. The substation contains a bank of oil transformers which lowers the tension to 380 volts. This current is then converted by a set of rotary groups. The latter consist of non-synchronous motors coupled to 170-horse-power generators, working at 735 revolutions. The generators, which are of the four-pole type, deliver 800 volts for the line. In parallel with these machines is a storage battery of 390 cells.

C. L. DURAND.

Paris, February 24.

TELEPHONE ENGINEERING.[1]

BY J. J. CARTY.

(Concluded.)

While engineers were endeavoring to plan systems in accordance with the flat-rate method, difficulties were encountered at every hand. As soon as the message-rate system was adopted all of these difficulties disappeared, and many positive advantages, not even suspected as residing in the message-rate plan, developed. Under the flat-rate system there was every temptation for the subscriber to send as many calls as possible over one line. This, as I have already stated, resulted in overcrowding the line and was attended by bad reactions of every kind. Those having but small use for a telephone could not afford to pay the high flat rate which that method of working made it necessary for the telephone company to charge. The consequence of this was that only those having a large number of calls installed a telephone, and those having small use of the telephone made it a practice to use the telephones of their neighbors or did not employ the telephone at all. This practice on the part of the small user was a natural one in view of the fact that under the flat rate the telephone subscriber considered that it cost him nothing to allow his neighbor to use his telephone. All of this resulted in a system largely composed of overloaded lines. Under the conditions obtaining in our large cities the relief of an overloaded line can be obtained only at the expense of a second line, which in most cases meant doubling the cost of the telephone service. For this and many other reasons the desired relief could not be obtained under the flat-rate system.

By introducing into the large cities the message-rate system, and by placing proper limits on the load which should be carried upon one line, and by providing a graduated system whereby additional lines could be obtained on a basis proportionate to the amount of their use, relief from this overloading was afforded. More than this, under the message-rate system it is obviously for the interest of the telephone company to encourage the use of the telephone in every manner. For this reason it became feasible and desirable to install as many auxiliary instruments as possible. This was accomplished by providing for those who required two or more lines a switchboard located at the subscribers' premises, this switchboard being so constructed that as many local stations as might be required could be installed at a moderate equipment charge. Each one of these stations is so equipped that it may be connected with a trunk line to the central office or it may be connected to any of the other local stations without communicating with the central office. In this way not only was the central office substantially changed, but a very important advantage was obtained. Talking between local stations at a local or private branch exchange switchboard could be accomplished without any message charge, and constituted an important by-product costing the subscriber practically nothing. This development not only reacted upon the central office engineering and the general engineering of the plant, but also completely changed the state of affairs with reference to speaking-tube telephones, practically limiting the former speaking-tube system to special and peculiar conditions.

Considering these two examples of the method of charging which shall be followed upon toll lines and the method of charging which shall be adopted upon subscribers' lines, it will be seen that they in a most extraordinary manner affect the work of the telephone engineer. So profoundly do such considerations affect the proper engineering of the telephone plant that it must be said that good telephone engineering can not exist side by side with a bad system of rates or with improper business methods and organizations. Nothing more forcible than these examples needs to be mentioned in order to show the intimate relations between telephone engineering and business management.

From time to time, engineering methods involving new principles are brought forth. These, when found to affect the methods of the business office, should be submitted to the business management with a full and clear statement of their bearings upon the commercial work of the company. On the other hand there are, from time to time, business proposals and commercial methods which are under consideration by the business management of telephone companies and which, apparently, are only remotely or not at all related to engineering. In view of the many unexpected and important reactions which these proposals may have upon the engineering of the telephone plant, it becomes of the first importance that they should be scrutinized carefully from an engineering point of view, unless it is conclusively apparent that they will be without effect upon the engineers' plans.

Many other instances besides those which I have enumerated might be adduced, such as the effect of the three-minute toll period method of charging upon the various features of suburban trunking methods; and the complicated and disastrous reactions produced by the introduction of many of the party-line systems.

Thus far I have dealt with some of the more general methods of telephone engineering, indicating briefly their nature. One of the very important features of telephone engineering consists in the design and construction of the varied machinery constituting the modern telephone central office apparatus. A brief statement, therefore, indicating the character of the work which devolves upon the telephone engineer in connection with central office design is pertinent.

During the ten years just passed, a revolution has taken place in the design and construction of telephone switchboards, the magneto-switchboard, so-called, having given way to the common battery switchboard. This radical change in telephone practice made new demands upon the telephone engineer, for it became necessary for him to introduce into central office construction certain elements which had theretofore been utilized principally in engineering work involving electric light and power installations.

In the magneto system signaling from the subscriber's station to the central office was accomplished by means of a small alternating-current generator turned by hand, and the current supply needed in the working of the transmitter was obtained from a few cells of primary battery located at the subscriber's station. By the introduction of the common battery system all of this was changed. The magneto-generator was dispensed with as was the primary battery, the current supply for operating the transmitter, as well as that required to enable the subscriber to signal, being drawn from a large storage battery located at the central office.

In the case of a 10,000-line switchboard the storage battery must be capable of giving an average discharge of 500 amperes, and to ensure proper working conditions it must be capable of giving a safe discharge as high as 2,000 amperes. For charging such a battery as this suitable machines must be employed, and these must be present in duplicate or triplicate. The standard machine used for charging a battery of this type delivers 1,000 amperes.

The introduction of currents such as these, and the introduction of these machines and of a large number of auxiliary machines generating currents for special purposes, has resulted in the creation of

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a power plant at each central office, upon which the operation of the telephone switchboard and apparatus is wholly dependent. The introduction of these larger currents has necessitated most careful and refined methods of fusing and protecting the delicate telephone apparatus. These protective methods, while following the general principles of such methods in electric light and power practice, are vastly more refined in their working and call for a hitherto unattained degree of precision in the manufacture of such apparatus.

While the storage batteries and auxiliary machinery employed in telephone power plants are far from equaling the magnitude of similar apparatus employed in electric light and power stations, nevertheless they have become such a vital element of the successful engineering of a telephone central office that they require on the part of the telephone engineer a special knowledge of this branch of electrical engineering, which was formerly not requisite. This class of apparatus must also be considered by the telephone engineer in a special manner, for not only must it be properly constructed from the electric light and power point of view, but peculiar conditions must be provided for on account of the association of this apparatus with such a delicate instrument as the telephone.

Where a dynamo is to be constructed to operate incandescent lamps, let us say, certain minute fluctuations in the potential of the machine are permissible. Were such a machine, however, to be used in connection with telephone circuits, these fluctuations in potential would be sufficient to produce such constant humming in the telephone as to render it inoperative. Hence a greater refinement of the construction of these machines in this respect is imperative where they are employed in the telephone power plant.

So it is with the storage battery, where a number of telephones are supplied by current from one storage battery; even almost infinitesimal changes in the voltage of the battery might be propagated to the telephone lines connected therewith and produce disturbances. For this reason storage-battery practice from the telephone point of view presents problems which are different from those encountered elsewhere.

One of the interesting and important developments in the modern common battery switchboards is the extensive use which has been made of incandescent lamps in signaling. Hundreds of thousands of these lamps are now used for telephone signaling, and the requirements of the telephone art have called for special refinement in the design and manufacture of these lamps.

While the common battery switchboards as now used in all of the large central offices represent a revolution in methods, as compared with the magneto system, there are certain elements formerly used in the magneto system which have persisted. Among these is the multiple-board principle. This principle, as is well known, consists in extending a number of lines to different points in the switchboard so that it is possible to connect with them at any one of these points. The multiple system is opposed to the transfer system, which is one wherein the lines are not so extended or multiplied to different points, but proceed directly to a special location from which trunk lines extend to other parts of the switchboard, so as to provide for making the necessary connections. It is safe to say that during the past twenty years there has been no question of switchboard design that has been the occasion of so much discussion and controversy as that pertaining to the extent to which the multiple principle should be adopted. It is interesting to note therefore that no type of switchboard of any magnitude is now seriously considered which does not in a very substantial manner utilize this multiple principle.

In a self-contained central office, with relatively few trunk lines extending to other offices, it is found most economical to multiple all of the subscribers' lines to each section of switchboard. In very large cities, where a number of central offices are required and where the amount of trunking between the different central offices is relatively large, the advantage of multiplying all of the subscribers' lines to each section is not so apparent as in the case of the self-contained office, and this fact has led many to the conclusion that for such situations multiple boards are not adapted. But this is going farther than the fact warrants, for while it is true that the advantage of multiplying the subscribers' lines to all of the sections of the switchboard becomes less and less as the percentage of trunking increases, it is still a fact that the point is never reached where the multiple principle should be abandoned entirely.

The truth of this proposition may be easily established by assuming that in a large city all of the calls must be trunked, and that none of them is local to the office in which they originate. In such a case as this it is obvious that nothing could be gained by extending all of the subscribers' lines before each of the operators. On the other hand, it is still essential that the outgoing trunk lines should be extended, or multipled, before all of the subscribers' operators, and all of the subscribers' lines should be multipled before the trunk operators. While the case of an office without any local calls is one which could not occur in practice, there are situations in which the amount of local calls is so small that it will not pay to multiple the subscribers' lines to all of the subscribers' operators. Just when this point is reached is a question to be determined in each case.

Thus far the instances where it has been found possible to omit this multiplying of the subscribers' lines are few, but as time goes on the number of these cases must increase; but at no time, so far as can now be seen, will the point be reached where the multiple principle itself will be abandoned. Even in the automatic switchboards, which constitute one of the most interesting of the recent developments, the multiple principle is found to be essential to the working of all types of automatic boards thus far proposed, wherever the switchboard is of any substantial magnitude.

With reference to this matter of automatic telephone switchboards I may say that such types of apparatus have, during the past few years, become a matter of great interest and the subject of much discussion among telephone engineers, and as I have made a number of special investigations into this subject I think it would be of interest if I here briefly state some of the results which I have obtained.

Upon a first view of the case the idea of using automatic machines and thus doing away with the labor of telephone operators appeals with much force, and the wonderful things which have been accomplished by American labor-saving inventions naturally come to mind. Among all of these projects for saving labor by automatic machines none seems more wonderful than the little machine which, when manipulated by the subscriber, will put him into communication with anyone out of thousands or tens of thousands of people scattered over a wide area. But in order that an automatic telephone switchboard should be properly called a labor-saving machine it must accomplish its work at an expense entailing less annual charges than would be required by the system which it attempts to displace. If it should be found that the annual charges of operating the automatic system were equal to or greater than the annual charges of operating the manual sys-

tem, then the automatic system would not be a labor-saving one, and, considered from the standpoint of costs, would be a failure. Whatever merit it would have, in that event, must be looked for in some very superior results in the way of service. From this point of view I have considered the merits of the various automatic switchboard systems which have thus far been installed.

I find that, taking into account all of the factors involved, and which go to make up the total annual charges which could properly be placed against the automatic switchboard system, on the one hand, and the manual system on the other hand, leaving out of account switchboards suitable for use only in small villages, and making comparison up to switchboards of 10,000 lines capacity, that the annual charges upon the automatic system are substantially greater than the annual charges upon a manual system operated on the common battery multiple plan. From the standpoint of costs, therefore, the automatic system fails when placed in competition with the common battery multiple-board operated manually.

Having found that the automatic system could not successfully compete with the manual system in point of costs and annual charges, I made a careful investigation to determine whether the automatic system possessed any advantages of working over the manual system which might compensate for the extra annual charges which its use necessitates. For this purpose there were made about 7,500 service tests on manual switchboards and automatic switchboards operating under practical conditions in different parts of the country. The results of these tests showed that the manual system possessed a most substantial greater degree of reliability than the automatic system. The difference in speed of connection between the two systems was so small as not to constitute a practical factor, the time elapsing between the start of the call and the answer of the called subscriber being in the case of the automatic system 19.9 seconds, and in the case of the manual system 21.7 seconds. These figures include the time taken by the subscriber to answer, and even this small difference of time was found to be due to the fact that the subscribers whose lines were tested answered somewhat quicker in the automatic system than in the manual system. It will be seen, therefore, from these tests that the automatic system possesses no practical service advantages over the manual system, and that it contains no elements sufficient to warrant any part of the extra cost which its use involves. A full consideration of the details of the comparison of these types of switchboards would lead me far beyond the limits assigned to this paper, and would only result in showing that the alleged advantage of doing away with the operators at the central office is imaginary and not real.

All of the foregoing relates to switchboard systems smaller than 10,000 lines, no automatic switchboard of larger size having been installed.

In order to determine whether for systems larger than 10,000 lines the automatic principle might be applicable, I made a study, assuming a system of 100,000 lines to be equipped with automatic switchboards, and compared this with a similar system equipped with common battery multiple switchboards operated on the manual basis. Here again the comparison is in favor of the manual board, both in point of annual charges and in respect to the service.

In applying the automatic switchboard to this 100,000-line study, it was necessary to leave out of consideration a very large class of difficulties which crop out at every turn when the attempt is made to apply the automatic principle to the complex conditions which obtain in and around all large cities. Inasmuch, however, as the study showed that the automatic system is inferior to the manual system for a 100,000-line plant, it became unnecessary to take into account the large number of adverse factors which must be charged against the automatic plan of working. So important are these factors that it is safe to say that even if the annual charges on the automatic system were substantially less than those on the manual system, they would constitute such a serious objection to the automatic system as to bar its use.

Throughout these investigations the importance of retaining at the central office operators to receive and attend to the subscribers' calls has been emphasized in so many important and unexpected ways that I have no hesitation in saying that no plan thus far employed, which requires that the subscriber should operate a machine and send his call automatically to the central office, can successfully compete with the plan which requires that the subscriber should remove the telephone from the hook and send the call orally to an operator at the central office.

Closely associated and interwoven with the design and construction involved in telephone engineering is the matter of the materials to be used. To the proper choice of material, as well as to their proper arrangement in the plant, the telephone engineer must devote serious and constant attention. All materials which are permitted to form a part of the telephone plant must be carefully studied by the telephone engineer, so as to obtain out of all those possible to use those which offer the best combination of first cost, durability, low annual charges and high efficiency.

Considering the almost innumerable varieties of materials used, all of which must be covered by standard specifications, the work of this branch of telephone engineering, taken by itself, would require so much time to describe that I will not attempt to enter into it in any detail, except to say that it constitutes one of the important duties of the telephone engineer.

Intimately connected with this matter of the choice of material and making the specifications therefor is the complementary function of accepting or rejecting that which is offered. The drawing up of the specifications must be attended to with the utmost care, so that they may be placed in the hands of the purchasing agent, and be sufficiently intelligible so that any manufacturer or person skilled in the art can understand their purport and supply without further information the articles desired. The drawing of such specifications is of very great importance, for not only must the articles desired be clearly described, but the language used must be such that no material other than that desired can be furnished under this specification. At the same time, while every precaution must be adopted in the specification to exclude undesirable material, great care must be exercised that undue and excessive requirements should not be specified. Otherwise the cost of the materials would be unnecessarily increased. Here, as well as at almost every turn in the work of the telephone engineer, there is no safe side. If the specification is made too rigorous, and calls for material of a quality in excess of that which is demanded by the nature of the construction, loss will result. On the other hand, if the specification is drawn loosely or so as to admit inferior material, loss will result, owing to defective working of the construction in which such materials would enter.

So far as I have gone, I have described the more typical functions of the telephone engineer. In addition to this, there are constantly arising questions demanding special investigation. The range of these questions is almost unlimited, and their adequate treatment requires most laborious and serious effort on the part

of the telephone engineer. While their range is so extended as to cover almost every field of engineering in scientific progress, and while the telephone engineer can not be expected to be expert in all departments of scientific investigation, he is required to direct such investigations, employing, as his judgment may dictate, experts in various departments to report upon those phases of the work in regard to which they may be best qualified t speak.

Thus far I have discussed the work of the telephone engineer without particularly calling attention to his relations to the telephone organization at large. This relation can best be understood by stating that the telephone engineer in every well-organized telephone company must, in the first place, broadly determine all of the important features of the plant of the company, and he must in detail decide what shall be the nature of the construction and the method of operation of every single item which constitutes the physical property of the telephone company. If, through defective design, a telephone cable is found to be ineffective, mechanically or electrically, it may be said in a properly organized telephone company that the fault lies with the telephone engineer. If, through defective design, the telephone switchboard is found to be unsuitable with respect to its maintenance or operation, the fault lies with the telephone engineer. So on through all of a multitude of items which constitute a telephone system. If, in a well organized and well administered telephone company, the plant is not constructed in accordance with the best state of the art, the fault lies with the telephone engineer.

That this must be so will be made clear by describing the method which obtains in well organized telephone companies of getting from the board of directors the necessary appropriations for carrying out all construction and reconstruction work. Under such conditions a development study will have been made and will have been approved by the business management. The traffic department will have, from its careful watching of the extent of the available facilities, given due notice of the time at which additions, changes or renewals of switchboard facilities may be required, all of which are presumed to have been contemplated in the broad plans already approved by the business management. The construction department will have, from its constant watching of the available cable and line facilities, given due notice of such changes, renewals and additions as may be required in these parts of the plant to accommodate the growing business and fit in with the approved general plan. In the case of the traffic department, the demands of the service having been thoroughly studied by them and the essential data having been supplied to the engineer, the necessary detail studies, plans and specifications are prepared by him and an estimate prepared for the work required. A case will be made out setting forth the nature of the work and the necessity therefor, and an estimate showing its cost and a specification describing the work in detail will be submitted to the management, and if in proper form it will be duly approved. The estimate and specification will then be turned over to the proper department and, depending upon the nature of the construction, the work will be executed by the telephone company itself or by a contractor.

The work must be supervised, as far as may be necessary, by the engineer, and upon its completion he must accept it or reject it. Having accepted it and having made a report to that effect to the business management, the transaction is completed. By this acceptance of the work, the engineer assumes full responsibility for its efficiency.

So it is with the cable plant, except in this instance, as a matter of administrative efficiency, the superintendent of construction may submit detailed plans for the extension to the cable and wire plants, following, however, general lines which have already been standardized by the engineer. These plans and specifications having been accepted by the engineer, and the work having been passed through the regular routine, the ultimate responsibility rests in the engineer's office.

So it is with other features of the work. From beginning to end the engineer is thus placed in a position to exercise a veto power upon any adverse methods which might otherwise be allowed to creep in.

The carrying out of this estimate system in this way places final responsibility upon the engineer and recognizes in the most practical manner one of his most important functions, which is to coordinate the various elements which must be put together in such a manner as to avoid conflict and produce a consistent symmetrical organism, each part of which will be designed and constructed with due reference to the functions which it must perform and also with due regard to the functions and importance of all other elements in the system.

The importance of this coordinating function can not be overestimated and it is only at some central point that such function can be exercised. Being judged from the maintenance point of view, a piece of apparatus might have qualities of a high order, but when considered with reference to its effect upon the traffic, difficulties might be discovered which would entirely overweigh the maintenance advantages. In such a case the conflicting claims with respect to the apparatus must be considered by the engineer, and his decision must be rendered with a view to producing the best net result.

Again, systems might be proposed which, considered solely from the maintenance, construction and traffic points of view, might seem to possess all of the advantages of an ideal arrangement, but when considered from the standpoint of the efficiency of transmission might be found to involve an impairment of transmission on one hand or such increase in cable and line costs on the other hand as to render its use out of the question.

In order to exercise proper coordinating functions, it is essential that the engineer should be placed and should maintain himself in such relations with all of the departments of the telephone organization that he may get from them and fairly consider all of the projects and ideas pertaining to the design, operation, construction and maintenance of the plant which naturally originate in such departments when they are conducted with proper efficiency.

Viewed from this standpoint, it will be seen that while the function of the engineer with relation to the plant is of the utmost importance, nevertheless the work of the traffic, maintenance, construction and other departments has such an important bearing upon the whole system that the successful engineering of a telephone system must be regarded not only as the work of the engineer himself but as the work of all the other departments concerned. Not only this, but what is still more important, the successful engineering of a telephone plant depends upon proper business management, as I have indicated by several striking examples. Without an intelligent, progressive and broad-gauged business management, there can not be good telephone engineering.

The Chicago Drainage Canal.

The case of the state of Missouri versus the state of Illinois, involving the right of the city of Chicago to divert its sewage into the Mississippi river through the Chicago sanitary canal and the Illinois river, has been decided by the Supreme Court of the United States in favor of Illinois. This decision leaves the way clear for the power development project, which is well in hand, for using the 40,000 horse-power in water power at Lockport, Ill., the lower end of the sanitary and ship canal. At this point there will be installed four 4,000-kilovolt-ampere, three-phase, sixty-cycles, 6,600-volt, alternating-current generators, now under construction in the shops of the Crocker-Wheeler Company, Ampere, N. J.

ELECTRICITY IN COKE-MANUFACTURING.

BY HOWARD S. KNOWLTON.

Within the last few years a number of important improvements in the processes of coke-manufacturing have been made possible by electricity, and there is good reason to believe that further applications can be made in the interests of economical operation. The central process in the manufacture of coke consists in driving out the gaseous elements from bituminous or other coal by heating the coal in special ovens, leaving behind the carbon constituent, fixed and deposited, and the residue of sulphur and phosphorus, together with the ash. Electricity is not directly used in the heating process, but it serves as a most desirable auxiliary in the handling of the product.

In the process of charging coke ovens the larries, which convey the coal from the crushing plant to the ovens, were formerly exclusively hauled by horses or mules along a path which had to be specially provided for the safe movement of the animals. The service of the ovens was consequently slow and unsatisfactory, a matter of special annoyance being the difficulty of stopping the larry at just the right place in front of the oven prior to charging. Aside from the time lost in thus "taking aim" at the oven door, a relatively long period was required to get the vehicles under way and up to speed, the acceleration possible with a horse manifestly being greatly inferior to that given by even a small electric motor. Gradually the motor has been introduced for this work, power being drawn from an overhead trolley, and many larries, formerly drawn by horses, are now equipped for electrical operation. A single motor geared to the wheels of the larry and controlled by a rheostat on the larry platform is generally installed, and there has seldom been any necessity for rebuilding the vehicles. Even when two or three horses are employed for such work, the results are inferior to those which the users of electric power enjoy, for it is no easy matter to obtain an even tractive effort with separate animals. The electric control is so perfect that the heavily loaded larry can be easily moved back and forth an inch or two at a time if desired, and in every plant thus equipped there has been a wonderful saving of time in the haulage of the coal. The better movement of the larries ensures a much quicker charging of the ovens after the coke has been drawn out, and increases the time of coking to the betterment of the resulting product.

The operation of machinery for drawing out the heated mass of coke from the oven is now effectively performed by the electric motor, and the extension of electrical equipment to the traveling cranes, which transfer the incandescent fuel in a cage to a cooling bath of water, is a natural step. The rapid acceleration possible with the electric crane greatly facilitates the application of the quenching process, and the results in the way of moisture expulsion by internal heat are far superior to those obtained by the old and slow method of cooling by means of a hose stream. Incidentally there ought to be a good field in coke-manufacturing for the scientific study of the oven action by means of the electric pyrometer, for there is no question that accurate knowledge of the temperatures at all stages of the process is essentially important in industries employing high temperature equipment. With the electric pyrometer the temperature of any one out of two or three hundred ovens can be recorded or indicated at a central point if desired, and a foreman can give instructions by telephone or electric bell signal to any oven attendant he may wish.

Non-condensing steam engines are usually employed to drive the various crushing, rolling, screening, washing and pumping machines which prepare the coal for the coke ovens, and it is a question if it would not in many cases pay to substitute electric motors in this work. With electric larries power must be either purchased or generated by the coke manufacturer, and there is no question of the inefficiency of the ordinary single cylinder hoisting engine in comparison with the electric motor. Of course, coal is generally extremely cheap at a coke oven plant, and the total cost of crushing per ton of 2,000 pounds frequently falls below one and one-half cents, while the cost of putting a ton through jigs and washers does not, as a rule, in good practice exceed ten cents. But the engine plant requires nine skilled operators; the steam consumption per horse-power-hour is liable to exceed 250 or even 300 pounds, against say, forty pounds per motor horse-power-hour in a generating plant which operates water-driven larries, electric lights, crushers and jigs upon a small well-designed wiring system. The saving of even one-quarter of a cent per ton in crushing and washing would, in a coke plant turning out 3,000 tons per day, amount to $2,250 per year, so that it is plainly evident that small economies are not to be despised even in plants where fuel is exceedingly cheap. An outfit of enclosed motors for coke-manufacturing service does not require anything like the attention in the way of oiling and maintenance which a large outfit of donkey engines demands, and as coke manufacturers realize the advantages of electricity for the severe service which their plants require, the present increasing use of electric power is sure to bear good influence in the productive economy of the coke business.

Mercury Arc Rectifier Operating in Multiple with Motor-Generator.

The Pacific States Telephone and Telegraph Company, San Francisco, Cal., has a forty ampere storage battery in use in its exchange at Alameda, Cal. Until recently this battery has been charged from an equipment consisting of a small direct-current generator driven by a single-phase motor, of only sufficient capacity to charge the battery at about thirty amperes.

This company had recently purchased a twenty ampere General Electric mercury arc rectifier outfit, and installed it in the Alameda exchange in order to test it in commercial operation. The load on this exchange is so heavy, however, that if the battery were to be charged at only twenty amperes, it would be necessary to keep the charging current on for twelve or fifteen hours per day. It was therefore determined to try to operate the rectifier in multiple with the direct-current generator, and charge the battery at the normal rate of forty amperes. The generator was started up and thrown on the battery, and the voltage adjusted to give about ten amperes charging current. Next the rectifier was started in the usual way, adjusted to charge at about twenty amperes, and thrown into parallel with the generator. The generator voltage was then raised until the current through the battery was forty amperes, and the charging proceeded.

As the electromotive force of the battery rose and the rectifier current fell off, due to the higher voltage of the generator, the voltage of the rectifier was raised by means of the rheostat at the bottom of the panel. The rectifier voltage could also be varied while the rectifier was operating by moving the compensating reactance switch, as the voltage of the generator kept the arc going while the switch passed over the dead points.

This scheme of operating the mercury arc rectifier in parallel with the generator has been in regular operation ever since it was first tried, and the attendants are very much pleased with it, as they are now enabled to charge the battery in three-quarters of the time previously required.

THE ELECTRICAL MANUFACTURING OF NITRATES IN NORWAY.[1]

BY SILVANUS P. THOMPSON.

The process which I have to describe to you is the invention of Birkeland and Eyde, and it has been at work on a sufficiently large scale and for a sufficiently extended time to enable a fair estimate to be made of its value in the practical sense. The inventors are not unknown persons. Professor Christian Birkeland is professor of physics in the University of Christiania, and Mr. Samuel Eyde is a well-known engineer in the same city. They have been associated together since 1903 in developing the electric furnace in which the nitrogen of the air is burned, in the large scale researches in their experimental laboratory at Arendal, and in the creation of the saltpetre factory at Notodden in the Hitterdal, under the auspices of a society which they have created under the name of "det Norske Kvaelstof Companie."

If an arc formed between electrodes by an alternating current of high potential is subjected to the influence of a transversely applied magnetic field, it is blown out laterally into a series of curvilinear streams which spring from the electrodes both above and below and enlarge themselves into a veritable disc of flame. The action of a magnet on an arc is not an unknown thing. It has been used over and over again in arc lamps, in electric blowpipes and in magnetic blow-out devices. But it does not seem to have occurred to anyone before Birkeland to utilize the peculiar disc of flame characteristic of the high-voltage alternating arc. If, using a transformer to give us the necessary high voltage, we let such an arc play between two horizontal electrodes, we have a phenomenon totally different from that of the arc such as we have in arc lamps. There is a single, short, stationary, almost invisible flame of enormous heat, raising to white incandescence the tips of a pair of carbon rods. The potential between the electrodes is only some forty to eighty volts, and the flame is silent. In Birkeland's flame we have a series of discharges, alternately above and below the electrodes, which discharges are approximately semicircles that, beginning with a radius of, say, one-quarter inch, enlarge themselves with great rapidity under the influence of the magnet, moving outward like the ripples on a pond, and enlarging until—in the actual furnaces used—they attain a radius of some three feet. This new kind of arc is best formed when the potential is from 3,000 to 4,000 volts; the temperature is probably higher even than that of the carbon arc, and it roars tumultuously.

Though there is nothing here that a physicist would not recognize as exactly what might be expected from the given conditions, the Birkeland flame constitutes an absolute novelty as a weapon for attacking the fixation of atmospheric nitrogen and kindred problems. It was recognized as such by Professor Birkeland, who forthwith called into association and partnership Mr. Eyde, whose engineering training and experience, no less than his genius for organization, led to the industrial development of the idea. They constructed electric furnaces, small at first, larger as experience guided them. They surrounded themselves with a staff of capable young men, highly trained chemists from the Technical High School, of Charlottenburg; electrical engineers from the Polytechnikum, of Darmstadt; engineers and physicists from the University of Christiania, and agricultural chemists from the Royal Agricultural School, of Aas, in Norway.

But before I speak further of the Birkeland and Eyde furnace and of the saltpetre factory at Notodden, let me point out how particularly suitable this flame is for the purpose at hand. We have seen how the very essential of the process is that the molecules of the air should be subjected to a very high temperature and removed as rapidly as possible. Now all inventors in this field have sought to attain this mechanically by blowing the air through the region where the electric sparks were produced. The velocities attainable are limited by the pressure at which the air is blown. But it does not seem to have occurred to any previous inventor to move the arc or flame across the air. The movement of the arc itself under the influence of the magnetic field may, however, attain a much greater velocity than could be conveniently given to the air. This circumstance gives a prima facie reason for the efficiency of this particular process.

The furnace in its practical form is extremely simple. On each side of the roaring disc of flame there are fire-clay cheeks pierced with holes for the inlet of air, which is driven into the central region under a gentle pressure by a Roots blower, and passing radially arrives at a peripheral channel whence it is conducted away. The whole is enclosed in an external copper case, into which, on either side, there enter the poles of a large electromagnet. The horizontal electrodes are of copper. They approach one another to within about one-third inch and are hollow, to permit of their being cooled by a water circulation that keeps them from fusing. They are not consumed, and need only to be replaced at intervals of a few weeks when they have become slightly eroded or roughened on the surface.

The first experimental work, in July, 1903, was made in a factory in Christiania with a small furnace taking three kilowatts to four kilowatts of power, which was shortly increased to twenty kilowatts. In three months a small research establishment was set up at Ankerlokken just outside Christiania, next to the electric supply station, and a larger plant of 120 kilowatts was constructed, with appliances for collecting the nitric fumes and converting them into nitric acid. In September, 1904, the work was removed to the extreme south of Norway, where, at Vasmoen, about twenty miles from Arendal, an experimental factory was erected on a spot where electric power to the extent of 500 kilowatts could be obtained from a waterfall. Six resident engineers and chemists and twenty workmen constituted an adequate staff. By this time the possibilities of the process had been sufficiently proved, and no time was lost in erecting the first commercial factory. A cheap electrical supply was the first consideration, but no less important was the question of convenience of shipping the products. The place chosen was Notodden, in the Hitterdal, on the shores of the Hitterdal lake, whence there was water communication through the canal to Skien, and thence either to Christiania or to Hamburg. The factory at Notodden, which is conceived on a scale competent in the first instance to turn out from 3,000 to 5,000 tons of product per annum, with ample room for extension, and a prospect of ample power from the neighboring waterfalls, rose with surprising rapidity, and began regular operations in May, 1905.

But now it is necessary to speak of the products of the process. Nitric oxide fumes formed in the arc at once absorb a further quantity of oxygen from the unconsumed part of the air and turn to nitric peroxide, and this when treated with water combines to form nitric acid. But nitric acid, valuable though it is, is a most undesirable substance for transportation. It is obviously easy to absorb the acid in caustic alkali, and to produce nitrate of soda. But here two difficulties present themselves. Caustic soda is not a natural product in Norway and would require to be imported for the purpose; and the liquid formed by treating the nitric oxide with water contains nitrous

[1] Excerpt from a lecture before the Royal Institution, London.

acid as well as nitric acid, so that the product would be a nitrate of soda containing a considerable proportion of nitrite of soda. For some purposes the presence of nitrite would be objectionable, though, as recent experiments of Professor Schloessing show, the prejudice against nitrite as a manure is largely unfounded. It was therefore decided to employ lime as the basic agent; and as a very pure limestone can be procured in any quantity in the neighborhood, it is easy by merely leading the crude acid into vats containing limestone to produce nitrate of lime. The nitrite present can be eliminated by a further addition of nitric acid, the nitrous gases evolved being led back into the absorbing chambers and mixed with fresh gases from the furnaces and absorbed afresh. So it comes about that the product which the Nitrogen Company, of Norway, is putting on the market is neither nitric acid nor nitrate of soda, but nitrate of lime. This substance, which is not found anywhere native, though it undoubtedly occurs in small quantities in the economy of nature in calcareous soils, where plants are assimilating nitrates from ammonia, can be produced in several different states. It forms clear crystals containing four molecules of water of crystallization. Secondly, if the liquor is concentrated by evaporation beyond this point a nearly anhydrous nitrate of lime is produced containing about thirteen per cent of nitrogen. Thirdly, by the further addition of caustic lime a basic nitrate of lime is produced which is quite anhydrous. The suggestion of this basic nitrate is due to Dr. Rudolph Messel, of London. As will be presently shown, the nitrate of lime is, in proportion to the amount of nitric acid it contains, the equivalent as a fertilizer to nitrate of soda; and for certain kinds of soil the circumstance that lime, not soda, is its basic constituent is a positive advantage. Pure calcic nitrate, moreover, commands a market of its own in preference to nitrate of soda for certain uses in the chemical industry in the manufacture of coloring matters.

Very wisely, therefore, the Nitrogen Company determined, in starting its factory at Notodden, that it would confine its operations to the sole production of Norwegian saltpetre—that is, of nitrate of lime.

The research laboratory at Vasmoen, near Arendal, merits more than passing mention. There are here several kinds of furnace, including one of a new vertical pattern, of 250 kilowatts to 300 kilowatts, and several others of different sizes. The laboratory is, in fact, a small factory equipped with every device for precision of measurement. Electrical measuring instruments are, of course, installed—voltmeters, amperemeters, wattmeters; also an oscillograph for study of the alternating currents. An electrical pyrometer measures the temperature of the air. Air meters and pressure gauges control the air supply. In the chemical laboratory daily records are kept of the titrations of samples drawn from the furnaces and from the liquors in the absorbing towers. It would be difficult to imagine a more thoroughly scientific equipment. It is not hampered by commercial routine, and has already undertaken the investigation of several other new chemical processes of kindred nature.

On the other hand, there is nothing experimental about the factory at Notodden. Though so recently erected, it bears the aspect of a regular industrial routine. The workmen go about their duties as if they had been brought up to them from boyhood; the hum of the furnaces resounds night and day. Boats come to the quay laden with limestone or depart charged with a cargo of sealed canisters of Norwegian saltpetre, en route for Skien.

Notodden was selected as the site for the first factory because of its advantageous situation for water carriage and cheap electric power. There are three furnaces of 500 kilowatts each. Air is supplied by blowers at about fifty litres per minute per kilowatt. The hot gases first pass through a steam boiler where they give up part of their heat to raise some steam, then they enter two large oxidation chambers, through which they pass slowly and emerge at a temperature of some fifty degrees centigrade to enter the absorption towers, about fifty feet high, built of granite slabs and filled with lumps of quartz over which water trickles. The first tower yields a fifty per cent nitric acid, the second about twenty-five per cent, the third fifteen per cent, the fourth five per cent. The liquids from the fourth tower are raised by compressed air to the top of the third, those from the third to the second, those from the second to the first, thus gradually increasing in concentration up to fifty per cent, at which density it is drawn off. The gases then pass through a fifth tower in which they are treated with milk of caustic lime, and finally through a wooden tower over beds of dry quick lime. The fifty per cent acid is treated with limestone to form nitrate of lime, which is concentrated as previously described, and poured molten into iron canisters ready for shipment. The number of workmen is surprisingly small, most of the processes being automatic. One single assistant engineer attends the three furnaces; and his principal duty is to enter in the log book every quarter-hour the readings of the electrical measuring instruments.

Though I am not at liberty to state the results of the tests made during my visit to the factory in August last, I may observe that Professor Otto Witt, who was a member of the visiting experts, has publicly stated that, according to his observations, the yield was between 500 kilogrammes and 600 kilogrammes of anhydrous nitric acid per kilowatt-year, and that not infrequently higher yields were observed under varying conditions. If we take the lowest figure of 500 kilogrammes per kilowatt-year, and assume the cost of electric power at 0.2 cent per unit, this would make the cost of the pure nitric acid (so far as electric power is concerned) $36.50 per ton, and the nitrate of lime, containing thirteen per cent nitrogen, would cost (in power alone) $22.50 per ton. To this, of course, would have to be added the additional costs in labor and supervision, together with interest on capital outlay, rents and the inevitable standing charges. But power, as obtained from the waterfalls of Norway, does not cost anything like 0.2 cent per unit. At about half a mile from Notodden is the waterfall called Tinnfos, where the river Tinne or Tinnelf drops in a fall of some forty feet. Here, some years ago, turbines were erected to take some 6,000 horse-power, which was applied at first to a pulp factory. The engineering conditions were so favorable that the capital expenditure was under $27.50 per horse-power, and the cost of production per unit only about ten kroners per horse-power-year, which is about 0.05 cent per unit. The owners of the pulp factory sell part of this power to the saltpetre factory at twenty-three kroners per horse-power-year, or at about $8.50 per kilowatt-year, or 0.094 cent per unit, yielding them a handsome profit.

So, then, the manufacture of the Norwegian saltpetre calls for nothing, save the machinery, that is not found ready to hand: air, water, limestone and electric energy.

The whole output of the present factory being readily absorbed either for the local needs of agriculture or by the buyers at Hamburg, enlargement is already begun. The present works will accommodate five more furnaces, and Tinnfos has still some spare power. But within a few months a new factory, more than double the size of the present one, will

be erected alongside, and the power for this must be bought from another source.

Three miles up the gorge of the Tinnelf is another waterfall, the Svaelgfos, which has some 29,000 horse-power, of which 26,500 will be available. A barrage must be erected, sluices made and a canal cut for some fifty yards down to the site of the power-house. Already some 300 laborers are at work on the needful construction. When completed, in about twelve months' time, this power will be transmitted to Notodden. The cost of power from this fall, as delivered at the factory, will be under $4 per horse-power per year—that is to say, less than $2.75 per kilowatt-year, or 0.03 cent per unit.

But the projects of the Nitrogen Company, of Norway, do not stop with the enlarged factory at Notodden. It has acquired powers for the utilization of three other waterfalls—Boilfos, near Arendal, with about 25,000 gross horse-power; Wamma, on the river Glommen on the Swedish border, with about 40,000 gross horse-power; and a still larger fall in Telemarken, the Rjukanfos. This fall is on the same stream as Tinnfos and Svaelgfos, but above the Tinnsjoe. In the heart of the mountains, behind Gausta, lies the lake Mjosvand, from which the river issues, and, after a course of about three miles, plunges down the Rjukan in a succession of falls, which give an available height of over 1,500 feet. Here there is about 300,000 horse-power at the maximum, of which a steady minimum can be utilized amounting to at least 220,000 electric horse-power. In the lower valley a still larger factory will be built, now that the fall and its possibilities have been favorably reported on by Mr. Turrettini, the highest authority on water power in Europe. In fact, nowhere else in Europe is there a water supply which presents so favorable a field for the enterprising engineer.

Experiments have been made at the agricultural station at Aas by Messrs. Sebelien and Bastian Larsen to test the cultural value of the nitrate of lime. The fertilizing properties of nitrate of lime appear to be, for equal amounts of nitrogen content, scarcely distinguishable from those of nitrate of soda. The Norwegian saltpetre appears to stimulate a slightly higher yield of grain, the Chili saltpetre a slightly higher yield of straw. In some tests on oats the Norwegian product gave a higher yield of both grain and straw. Professor Schloessing, of Marseilles, has lately investigated the use of the Norwegian nitrate, as well as of the nitrites of soda and of lime. For maize the nitrate showed itself the equal of Chili saltpetre to within less than one-quarter per cent, and the nitrites showed themselves to be, for equal amounts of nitrogen content, slightly superior to the nitrates.

If it is clear that not even all the waterfall power of Scandinavia, if devoted solely to the manufacture of nitrates, could yield an output equal to that demanded by agriculture, it is at least clear that with the approaching exhaustion of the Chili nitrate beds the value of synthetic nitrates, which already can be produced in concurrence for the markets of Europe, will be increasing every year, and will at least help to preserve for the white races a few added years of relief from the impending crisis.

THE TELEPHONE SYSTEM OF THE FUTURE—THE SEMI-AUTOMATIC.

BY LE ROY W. STANTON.

Three distinct types of telephone equipment have been developed—the magneto or local battery, the common battery or lamp signal, and the automatic system. The first two may be further subdivided into the transfer and multiple systems. At the present time two telephone systems are being developed which are the outgrowth of the systems mentioned above. One of these may be called the transfer or trunking system. It is applicable only to large cities. The other, called the semi-automatic, is applicable not only to the large cities, but to smaller cities and towns.

The trunking or transfer system is a development of the original transfer system. It is due to an effort to meet the increasing demands of the rapidly-growing telephone systems. In the early days of telephony, when there were but few subscribers, but more than one operator could take care of, the calls were transferred from one operator to another by what was known as a transfer. Later the multiple switchboard was devised, thus eliminating the transfer. Now the still greater increase in number of telephones has carried the capacity beyond that of the multiple switchboard, thus making necessary the establishment of branch exchanges with trunk connections. This growth has increased to such an extent that in some of the larger cities a score of branch exchanges are required. When a development so great as this has taken place, a large percentage of the originating calls in any one of the exchanges is for a subscriber in some exchange other than the one originating it. For this reason the subscriber's multiple, which is placed within reach of the A or originating operators, is used but very little, often ninety per cent of the calls being trunked to other exchanges. In such a case an expensive part of the central office equipment has an efficiency of only ten per cent and is not fulfilling the requirement for which it was intended, namely, that of eliminating the extra operator in making a connection between two subscribers.

The present tendency in large cities is to eliminate the A subscriber's multiple and treat every call as a trunked call. While this system is gaining favor over exchanges with the multiple system as used to-day in leading cities, it is far from being as economical in first cost or in operating expenses as a system which may be called the semi-automatic. Such a system, generally speaking, embodies the valuable principles of both the manual and the automatic. It eliminates a good number of the operators who are found in the manual system, and avoids the complicated mechanism found in the automatic system. It utilizes the telephones at the present time employed in the manual common battery system. Its operation is briefly this: a subscriber, upon lifting his receiver from the hook, operates in the main office a line relay similar to that used in the modern lamp signal board, but this, instead of lighting a line lamp, energizes a simple selector-switch which selects an operator who is not busy and, in turn, selects a connecting cord which is not busy and lights the lamp associated with this cord. The current lighting this lamp passes through a low-wound relay, which connects the operator with the subscriber. Upon receiving the number of the instrument wanted, the operator inserts the plug in the multiple and rings. Upon inserting the plug in the jack, the cord-lamp is automatically extinguished and the operator's listening set is disconnected at the same time, leaving the two subscribers to converse in privacy. This action also leaves the operator free to receive another call. When the subscribers finish their conversation and restore their receivers to the switch hooks, the lines are automatically disconnected. This leaves the line free to receive other calls or gives the subscribers opportunity to call again immediately. It leaves the plug in the jack until the operator removes it, but the automatic disconnecting of the two subscribers leaves this cord and plug dead. The busy test is taken off the multiple jack, and the disconnecting lamp signal corresponding to the cord used is lighted, thus notifying the operator to take down the connection.

With such a system an operator would

be constantly busy, and since she would never be overloaded nor ever idle, the service would be prompt and uniform. She can receive only one call at a time, due to the automatic distribution of the calls to any one operator. The subscriber, upon lifting the receiver from the hook, automatically is put in talking connection with the operator, who gives the number desired without waiting for a request. The operator repeats the number and glances at the keyboard, noting the lighted lamp which indicates the cord to be used in making the connection. Owing to the fact that she would not be required to use an answering cord, listening key, or ask for a number—operations which take up the greater part of her time—and owing to the automatic selections, she would probably answer three times the number of calls usually attended to by an operator under the present system in the same time. For night service, Sunday service or at other times when the load is light, the number of operators can be reduced. Owing to the fact that the first few operators receive all the calls, the last positions are only brought into service during the rush hours.

The system just outlined is especially applicable to towns and small cities. By means of a slight increase in the equipment an additional advantage is gained through automatic trunking and branch exchanges. In such a system automatic trunking equipment is used in the branch exchanges. A subscriber, upon lifting the receiver from the hook, operates a simple line relay in the branch office, which, in turn, operates a selector, which selects a non-busy trunk to the main office, whereupon the operator would be selected as described above. The operator, instead of making connections in the multiple, makes connections in an outgoing trunk, which terminates in the office to which the subscriber called for is connected. The operator at the central office is required to operate an ingeniously designed key, which selects the subscriber called for. Such a system not only increases the capacity of the plant very decidedly, but eliminates all of the trunking operators and a large part of the A operators. It also eliminates the multiple, answering jacks, line lamps, one-half the cords and plugs, and the intermediate board. The line relays are still necessary, and, in addition, a simple device for selecting the position and cord to be used are required. By using branch offices with the trunk selectors the cost of the outside plant may be greatly reduced. One trunk for every ten subscribers would be sufficient for carrying the business between the main and the branch offices. The apparatus at the branch office is a simple one-motion selector which would select a non-busy trunk to the main office. In calling the subscriber there will be an additional motion required of the selector, which will be simple, owing to the fact that there is only a small number of subscribers entering any one of the branch exchanges. By having small exchanges there is but a small number of subscribers to select. Thus a simple indicator suffices. Further, the wire mileage is reduced owing to the small area served by each branch exchange. Such a branch office may be installed in any suitable, inexpensive location—either in a building, in a special terminal box or on a pole.

The system, as here outlined, makes use of the simplest known form of substation equipment. It effects a large saving in the outside wire plant, it eliminates most of the objectionable features of central office equipment as found both in the automatic and manual systems, and it furnishes a superior service, since it is more rapid than either the manual or automatic. Further, it makes it unnecessary for the subscriber to operate a mechanism and thus make his own call. The subscriber is not subject to delay due to a busy operator, and, moreover, the service is secret.

NOTES FROM PERU.

BY EMILE GUARINI.

During the latter part of June or the first of July, 1905, the writer made a short visit to the southern part of Peru. The object was to determine what opportunities were offered for electrical development. The results of the visit demonstrated that very little has been done in this direction up to the present time. One installation of 1,000 horse-power supplies light and power to Arequipa, and a modest electric light installation has been made in the valley of the Tambo. On the other hand, there are enormous opportunities for electrical development.

During this trip stops were made at four points. The first was at Mollendo, where the canal delivering potable water could be used also for supplying power to a small hydroelectric station for lighting the town. The second stop was made in the valley of Tambo, where a visit was paid to the mansion of Don Eduardo Romana and to the sugar factory of M. Lira. In the latter there is a small electric installation, the dynamo of which is driven by a hydraulic wheel which is too small. The current produced here is used for lighting the factory and also serves for motive power. The numerous hydraulic powers which are found at this point alone, or but a short distance away, are sufficient to drive all the machines in the factory and on the farms, while at night the current could be employed for heating the boilers in order to produce the steam necessary at the factory.

The third stop was made at Arequipa, where the Chili at the present time supplies power for a station, with an output of 1,000 horse-power, about ten kilometres from the city. This furnishes public and private lights, and will be employed also for motive power. By means of a new canal and a new station, placed a few hundred metres lower down than the present one, it would be possible to develop about 6,000 horse-power. This could be used very effectively at night, supplying the power necessary for lighting Arequipa and its environs, and during the day operate, by preference through electrothermic traction, all or part of the railway of the south. If electric traction should be adopted the entire section of road could be operated.

The fourth stop was made at lake Titicaca. This lake is situated 3,800 metres above the sea level. By precipitating to the sea level 100 cubic metres of water per second, which is less than the water the lake receives from its affluents, and which is now lost through evaporation and filtration in the Pampas, 5,000,000 horse-power will theoretically be available. Practically at least 2,000,000 horse-power can be produced. The lake is lower than the hills and mountains surrounding it, and to carry out this development it will be necessary either to make use of a tunnel or to pump the water over the crest of the Andes in order to precipitate it on the Peruvian side at a point where the electrochemical industries can be undertaken. The water to be taken from the Peruvian territory can be utilized by means of one or several falls, and can eventually be employed for irrigation after having passed through the turbines. To the objection which might be raised to this development, because there are a number of rivers which descend on the Pacific side and which fall from 4,000 to 5,000 metres, representing hundreds of thousands of horse-power which could be developed more easily than the Titicaca plan, it may be answered that the first case would involve the carrying away of water now necessary for irrigation and already insufficient; while in the latter case 100 cubic metres of water per second, which at the present time is lost, would be made available for irrigation.

BOOK REVIEWS.

"Tables des Intérêts Composés Annuités et Amortissements." A. Arnaudeau. Paris. Gauthier-Villars, Imprimeur-Libraire. Paper. 125 pages. 7½ by 11 inches. Price, 10 francs.

This is a set of five interest tables for use in computing interest and depreciation at different rates for various periods up to 400 years.

"Les Accumulateurs et les Piles Electriques." J. A. Montpellier. Paris. B. Ballière et Fils. Cloth. 305 pages. 4½ by 7 inches. 130 figures. Price, 5 francs.

The book is divided into two parts, the first being devoted to a consideration of secondary or storage batteries and the second to primary batteries. That part on storage batteries gives a very brief discussion of the theory and describes in some detail the different types of element. Regulating and safety devices are considered at some length, as well as the most suitable switchboard arrangements. Instructions are given for the care and repair of these batteries. Part two, dealing with primary cells, describes the various types of cell most generally employed.

"Whittaker's Electrical Engineer's Pocket Book." Second Edition. Edited by Kenelm Edgcumbe. New York. The Macmillan Company. Flexible leather. 541 pages. 4 by 6½ inches. 161 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

In the second edition of this handy little book several chapters have been fully revised. That on the subject of dynamo design has been gone over carefully and the section on central stations has been much enlarged. The book gives the usual tables of units and measures, and mathematical constants and electrical data. The elementary theory of electricity and magnetism is briefly discussed and the characteristics of different electrical machines are described and their applicability to various purposes indicated. The book is intended to furnish the electrical engineer with information on branches of the art other than the one in which he is engaged.

"A Practical Treatise on the Steam Engine Indicator and Indicator Diagrams." Second edition, revised and enlarged. W. Worby Beaumont. New York. D. Van Nostrand Company. Cloth. 261 pages. 5½ by 8½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.50.

The intention of the author has been to make this book a concise guide to the objects, construction and use of the indicator and to the interpretation of indicator diagrams. The fundamental principles of the indicator are given and the development of this instrument from the time of Watt down to the present day is followed. Directions are given for attaching the instrument to the engine and for taking diagrams. Instructions for interpreting the diagrams and for constructing the theoretical lines from those obtained are given also. The use of the indicator for single, compound and multiple-expansion engines, and also for internal-combustion engines, is described carefully, and some interesting applications to other purposes are shown. A brief chapter tells how diagrams taken from engines out of adjustment should be interpreted. The book forms a complete treatise on the engine indicator.

"Alternating Currents—Their Theory, Generation and Transformation." Alfred Hay. New York. D. Van Nostrand Company. Cloth. 291 pages. 6 by 8¾ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.50.

An effort is made here to present a practical treatise on alternating currents. The method of treatment is somewhat different from that usually adopted. After giving a brief treatment of periodic currents and the reactions which they set up, the author passes to the consideration of measuring instruments, discussing first the theory of the wattmeter and the effect upon it of self-induction, capacity, eddy currents, etc., and shows what correction factors are necessary for errors due to the wattmeter itself and for unbalanced conditions of the external circuit. Various types of measuring instruments are described, some of them in detail. This is followed by a discussion of the direct-current dynamo as an alternator and then comes a discussion of alternator design. Next the subject of transformers is considered. This is followed by a chapter on the induction motor and another upon the synchronous motor. In each case it is endeavored to give practical information rather than theoretical deductions. The various methods of predetermining alternator regulation are discussed briefly, as well as a number of methods for conducting tests of generators, motors and transformers. The new types of alternating-current commutating motor receives a brief consideration, and a good deal of space is given to matters which are of recent origin and hence not generally found in textbooks.

"Motive Power and Gearing for Electrical Machinery." E. Tremlett Carter. Second edition, revised in part by G. Thomas-Davies. New York. D. Van Nostrand Company. Cloth. 672 pages. 6 by 8½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $5.

The second edition of this well-known treatise on the theory and practice of the mechanical equipment of power stations for electricity supply and for electric power and traction was revised in part by the author. His death unfortunately interrupted the work, but it was later taken up by Mr. Thomas-Davies and completed. The latter is particularly responsible for the revision of the chapters dealing with recent advances in the art, such as the description of typical steam engines, methods of testing, the use of superheated steam and the steam engine in relation to electric power. He has also revised and largely rewritten the two chapters on steam-power stations and gas and water-power stations, bringing these subjects up to date. Of the general character of the book but little need be said. It discusses first the fundamental principles underlying the production of mechanical energy and the transformation of this into electrical energy, and goes pretty thoroughly into the principles of thermodynamics. It discusses fuels and describes the proper methods of boiler setting. The theory of the action of steam, gas and oil engines comes in for a thorough treatment, attention being called to the various attempts to improve upon the Otto cycle. The use of belts, ropes and couplings of various kinds is taken up briefly. The chapter on steam-power stations deals principally with English or European power-houses. The same may be said of the chapter on gas and water-power stations, although here the plants at Niagara Falls receive a good deal of attention.

Report of the New York State Commission of Gas and Electricity.

The first annual report of the New York State Commission of Gas and Electricity shows some interesting facts. The total bonds and stock issued by all lighting and power companies of the state amount to $531,251,468.33, equal to about $75 per inhabitant of the state. There are 399 operative companies, of which seventy-one pay dividends on the stock. Of the 156 electric companies thirty-four pay dividends, and of the fifty gas and electric companies fourteen pay dividends. Individual and municipal plants represent an investment of $1.101,348.92.

The report does not give separately the gas and electric companies, but states that the amount of gas of all kinds sold to consumers is 36,397,747,816 cubic feet and the amount sold for public lighting is 1,569,446,124 cubic feet.

The report gives some interesting facts regarding the increase in stock and bonds of the gas companies since 1900. The preferred stock of gas companies was increased from $15,538,400 to $23,710,000, and the common stock from $101,492,116 to $130,837,111, and the amount of gas

sold from upward of twenty to upward of thirty billions cubic feet. The approximate increase of forty to fifty per cent, and about the same proportion of increase is shown in the capitalization of electrical companies except as to stock increase, which is about twenty-five to thirty per cent.

The municipal lighting industry shows thirty stations as compared with twenty-eight in 1900, with an authorized bonded indebtedness of $563,978, as compared with $519,340 in 1900.

The companies in New York city have seventy-eight per cent of the bonds and stock issued by companies in the state, and furnish ninety-three per cent of the gas sold to consumers. The average capitalization of companies furnishing gas alone is $5,194,213, while the average outside of New York city is $767,944. Of the purely electric companies New York city furnishes seventy-one per cent of the total capitalization and seventy-seven per cent of the number of commercial incandescent lamps of the entire state. Nearly one-half of the entire public enclosed arc lamps are in New York city, and 3,250 open arc lamps as against 2,045 in the rest of the state.

Of the 399 companies covered in the report 156 are electric, fifty-one coal and water gas, seventeen oil gas, thirty-eight natural gas, twenty-two acetylene gas, thirty municipal electric and three municipal gas.

The average maximum and minimum price of gas supplied by gas and electric and gas companies $1.56 and $1.30 for coal and water gas for lighting; oil gas, $1.98 and $1.74; acetylene, $14.58 and $14.05. If the companies are taken outside New York city the average is larger. The average stock and bond capitalization of electric companies issued is $1,188,251; of coal and water gas companies, $5,194,213, and of gas and electric companies, $1,475,588. The capitalization would be lower if the New York city companies were not included.

ELECTRIC STAGE LIGHTING AT NEW STADT THEATRE AT NURNBERG.

BY FRANK C. PERKINS.

The accompanying illustration, Fig. 1, shows the general arrangement of the electric stage lighting equipment of the City Theatre, at Nürnberg, Bayern, Germany, as recently installed by the Siemens-Schuckert Werke, of Berlin. There are nine sections of vertical lamps on each side of the stage in three colors, each section having a wire guard and provided with switches at the base for separate control when desired, as noted in the accompanying illustration, Fig. 2. The overhead hanging lights are mounted in frames, with sprocket chains and pulleys for adjusting at any angle desired, as shown in the three-color hanging section in Fig. 3. There are seven of these sections extending the whole width of the stage overhead and several shorter sections, as indicated in illustration, Fig. 1.

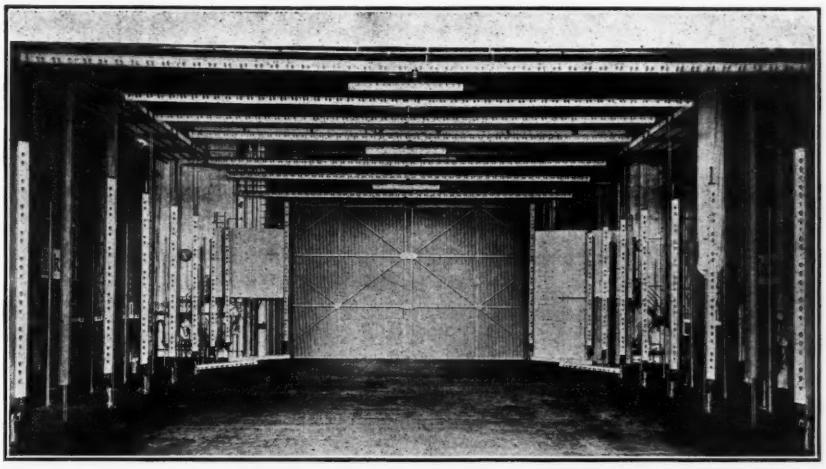


FIG. 1.—ELECTRIC STAGE LIGHTING, STADT THEATRE, NÜRNBERG, GERMANY.

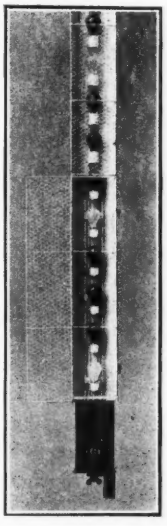


FIG. 2.—ARRANGEMENT OF ELECTRIC SIDE LIGHTS.

The lamps are all arranged in groups of three colors, each of thirty-two candle-power, operating on 250-volt circuit. The footlight section is also provided with guards and mounted in frames of the type noted in the accompanying illustration, Fig. 4. Portable reflectors are also provided, mounted on tripods, with twelve and twenty-four lamps in each section, arranged in rectangular form and also in circular frames. The Stadt Theatre, at Nürnberg, is also provided with footlights in the wings, as indicated in the illustration, Fig. 1, all of the connections to the vertical lamps sections in the wings being made through the floor with junction boxes and conduits.

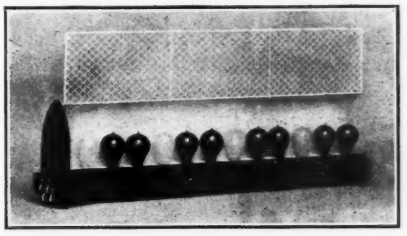


FIG. 4.—ARRANGEMENT OF FOOTLIGHTS.

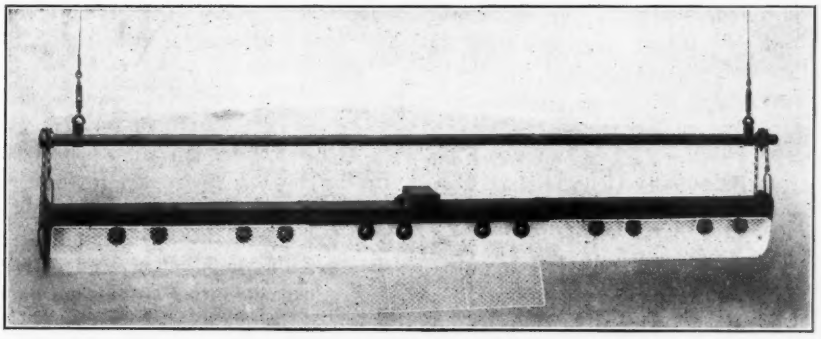


FIG. 3.—ARRANGEMENT OF DROP LIGHTS.

Electric Equipment for the Simplon Tunnel.

The question of using electricity as motive power for the Simplon tunnel in Switzerland has formed the subject of extensive studies by all the Swiss electrical manufacturing and engineering concerns. The advantages of electric traction were early realized by the Swiss government railway authorities. But the importance of the Simplon line as an international line made it impossible to use any system which had not already proved entirely satisfactory in continued operation, inasmuch as a break-down would have had the most serious consequences. For this reason years went by without any decision one way or another. To-day there are several examples of successful use of electricity as motive power on trunk lines, and the experience gained on these roads definitely decided the Swiss government toward the end of last year in favor of electric traction for the Simplon tunnel, more particularly also, because it was found almost impossible to provide proper ventilation for this tunnel if steam locomotives had to be used. It is well to point out in this connection that the Simplon tunnel is about thirteen miles long, or the longest tunnel in the world. The difficulties encountered elsewhere with smoke were therefore greatly intensified in this case.

The electric system to be used for the Simplon tunnel is the well-known three-phase alternating-current system already employed on the Lugano railways (1896), the Gorner Grat railway (1898), the Jungfrau railway (1898), the Stanstadt-Engelberg railway (1898), the Burgdorf-Thun railway (1899) and the Schwyz railway (1901), all in Switzerland, and the Valtellina railways (1902), in Italy.

The conditions under which the service is to be operated are as follows:

On each side of the tunnel, which, as above stated, is about thirteen miles long, hydroelectric plants are now already installed and these were used during the construction of the tunnel to generate the energy required by various boring and other machinery. These two power stations at Brigue and Iselle produce three-phase alternating currents at 3,300 volts and fifteen cycles per second, and inasmuch as the electric zone will at first be limited by the tunnel division proper, the electric currents will be fed directly into the overhead contact line without the use of any transformer or feeders. The contact line consists of two hard-drawn copper wires, suspended by means of special insulators from cross-suspensions, which in their turn are fastened to the walls of the tunnel by means of special hooks. Such suspensions are provided about every twenty-five yards, which distance was considered to be sufficiently small, in view of the fact that the more or less even temperature of the tunnel would prevent serious changes in the sag of the wires. The track will serve as the third conductor for the three-phase system and will be properly bonded. In the centre of the tunnel there is a piece of double-track, which will permit the passing or crossing of trains in cases of delays, etc. In normal service trains are not supposed to pass or cross each other. This piece of double-track will have suitable aerial switches at both ends, arranged so that the trains will always be in contact with both of the overhead wires, and therefore always in position to be electrically operated at will. The centre of the tunnel is also equipped with section switches, by means of which the two halves of the line may be isolated, and each thrown on its own power-house, while in normal service the two will be operated in parallel.

The trains arriving at either end of the tunnel will have their steam locomotive uncoupled and an electric locomotive put in its place, which will then haul the train through the tunnel. At the other end the electric locomotive will be uncoupled and the train will be hauled by steam to its destination. For a start it will therefore only be necessary to equip electrically the tracks pertaining to the two terminal yards. In some cases there are five such tracks side by side, and it was therefore decided to use iron poles throughout, by means of which the overhead contact wires will be suspended from cross-suspensions similar to those inside the tunnel. Where several tracks have to be spanned by one cross-suspension, the latter is strengthened by a special additional cross-wire, in the shape of a catenary, which gives the greatest stability with the least strain on the poles.

The locomotives to be used are partly some which are now in operation on the Valtellina line, and which were built by Ganz & Company and lent by the Italian to the Swiss government, and partly locomotives which were originally built by Brown, Boveri & Company for the Valtellina line, but which the Italian government permitted to be turned over to the Swiss government for use in the Simplon tunnel. The locomotives have three-coupled driving axles carrying about seventy-five per cent of the total weight, and two pilot axles carrying the rest. Each locomotive is equipped with two motors driving the drivers by means of coupling rods without the use of gears. The normal output of these motors is about 900 horse-power, the maximum output about 2,300 horse-power. There are two normal speeds of about twenty-one and forty-two miles per hour. The total weight of each locomotive is about sixty-two tons. The normal grade on the north side of the tunnel is 0.2 per cent, the normal grade on the south side is 0.7 per cent, the maximum grade in the stretch now to be electrified is one per cent. The service provides for hauling passenger trains weighing 365 tons and freight trains weighing about 500 tons. Passenger trains are to be run from Brigue to Iselle in twenty minutes, from Iselle to Brigue in thirty minutes. Freight trains will use in either direction about forty minutes. Trial runs will probably take place during the month of April and May, so as to have everything ready for the formal opening on June 1.

It is rather interesting to note that the choice of the Swiss government for the equipment of this most important railroad fell upon the three-phase alternating-current system, which for some reason or other has not been given the approval of American engineers in general, though it is warmly advocated by Mr. C. L. de Muralt and has been approved for certain cases by Messrs. L. B. Stillwell and F. N. Waterman, the latter having read an interesting paper at the last Asheville convention of the American Institute of Electrical Engineers which described detailed tests made by him on some of the European three-phase roads. Mr. C. L. de Muralt has, in several papers before the Institute, given interesting information concerning most of these European roads, and also made comparisons between the three-phase and the better known direct-current and single-phase alternating-current systems.

The decision of the Swiss government to use the three-phase system is undoubtedly due in a great measure to the fact that this system has been used for heavy traction over long distances, and, furthermore, to the fact that the investigations of the special committee appointed for the purpose of studying the results obtained by electric operation in general, showed that the reliability of this system in continued service is beyond doubt, and that the actual costs of repairs are extremely low. This latter is not strange if we consider that the three-phase system does not use any commutator on its motors, which means, of course, that that great part of

the cost of maintenance is entirely absent.

The general arrangement of this traction plant, as well as the details of construction of the locomotives, clearly show the intention of using to the fullest extent the constructive simplicity inherent in three-phase motors. Special care was taken to make all electrical parts as accessible as possible, and the security of service was increased by several very ingenious interconnecting devices, by which it is practically impossible for the motorman to make any wrong move. For instance, all boxes enclosing controlling and regulating apparatus can only be opened after the current-collecting device on the roof of the locomotive has been lowered by compressed air and is no longer in contact with the overhead line. Then, again, the current-collecting device can only be raised when the controller is on the zero point and other combinations, all tending to increase the security of manipulation.

The West Virginia Independent Telephone Association.

The second annual convention of the West Virginia Independent Telephone Association was held in Parkersburg, W. Va., Thursday and Friday, February 22 and 23. The association is composed of fourteen companies, as follows:

National Telephone Company, of Wheeling; the Consolidated Telephone Company, of Clarksburg, Grafton and Fairmont; the West Virginia Western Telephone Company, of Wheeling; the Huntington Mutual Telephone Company, of Huntington; the Charleston Home Telephone Company, of Charleston; the Weston Central Telephone Company, of Weston; the Buckhannon Telephone Company; Bigley Telephone Company; Point Pleasant Telephone Company; Ravenswood Telephone Company; Pennsboro & St. Marys Telephone Company; Parsons Telephone Company; Mountain State Telephone Company, and the Mannington & Smithfield Telephone Company.

Papers were read, and the following officers elected: president, W. C. Handlan, Wheeling; vice-presidents, first district, J. H. Wise, Cameron; second district, W. M. Cayton, Parsons; third district, J. W. Downs, Buckhannon; fourth district, Hugh Amos, Burnsville; fifth district, L. H. Hutchinson, Huntington; secretary, A. C. Davis, Parkersburg; treasurer, Lloyd Beghley, Weston.

Delegates to the convention of the National-Interstate Telephone Association were elected as follows: L. H. Hutchinson, W. C. Handlan and A. C. Davis.

Hydroelectric Plants of the United States, Canada and Mexico.

Under the title, "Hydroelectric Plants of the United States, Canada and Mexico," Arthur W. Clapp, M. E., E. E., 1164 Monadnock block, Chicago, Ill., will shortly give to the electrical engineering field the first volume of one of the most exhaustive treatments of this branch of the electrical industry that has been published for some time. Every plant of over 500 horse-power capacity, in the countries covered, will be described with the object of laying before the profession the intimate details of each hydroelectric power plant, its equipment, its location, its purpose and unique features.

The author announces that but few of the plants described in this work have ever appeared in print of any form, and the manner in which the matter is presented in the separate articles will bring the subject vividly before the reader.

The work will be in two or more volumes of 500 pages each. Each plant described is illustrated with photographs grouped on one page. The description of the plant gives the following subjects in detail: hydraulic features, construction of dam and power-house, detail of electrical and switchboard equipment and pole line, each article consisting of from 3,000 to 5,000 words. There are in all about 350 hydroelectric plants of over 500 horsepower in the countries above mentioned. To date about 250 have been described in the material received.

Accuracy as to data furnished will be the main feature of the work, the statistical matter being furnished by engineers now in control of the individual plants or by those under whom the plant was constructed. Before publication final proofs will be submitted to each company operating the plant described for correction.

This work to the extent of 2,500 copies is to have a free distribution among the electrical engineers in charge of the plants described and to those parties who contemplate the erection of hydroelectric plants. This distribution is made possible by the cooperation of a number of companies who are interested in the manufacture of hydroelectric equipment. A compilation of this character will be of great assistance as a reference book for years to come, and the author will be pleased to receive any information or statistics that will be of interest to the profession and valuable for publication in these volumes. As there will be an excess of a few copies of this work, Mr. Clapp will furnish gratis a complete set of the volumes to any reputable engineer or company upon application.

Missouri State Telephone Association Effects Plan of Organization.

On February 23, at the closing session of the Kansas City, Mo., meeting of the Missouri Independent Telephone Association, the details of a consolidation of all the companies were worked out. The state was divided into two sections, north and south of the Missouri river. The north section comprises districts Nos. 1, 2, 3 and 4, the remaining five districts forming the southern division. A merger of these sections will be effected, and when the situation warrants there will be but one general operating company. For the present there will be two companies, which will be organized as soon as possible. The details of the formation of the two companies will be handled by a committee for the whole state, composed of G. W. Schweer, Windsor; J. F. Barnet, Rutledge; Edward Hook, Appleton City; W. B. Scruggs, Harrisonville; H. McHenry, Jefferson City.

The New York Electrical Club.

The board of governors of the New York Electrical Club held a meeting on February 27 and elected officers as follows: president, J. P. Hall; vice-president, Henry L. Shippy; treasurer, Charles P. Scott; secretary, R. B. Corey.

Members of the house committee were elected as follows: Charles I. Hills, R. B. Corey.

The membership committee elected is as follows: Henry L. Shippy, E. B. Latham, E. S. Keefer and H. T. Johnson.

The club is arranging to lease a portion of a building downtown, and the house committee is preparing to furnish the rooms and hopes to have these ready for the club about the middle of March or the first of April.

The board of governors of the club is as follows: J. P. Hall, Henry L. Shippy, Charles P. Scott, R. B. Corey, Charles I. Hills, Charles W. Price, E. B. Latham, E. S. Keefer and H. T. Johnson.

The National Electric Light Association.

It is announced that the interest shown in the coming convention of the National Electric Light Association, to be held at Atlantic City, N. J., June 5 to 8, is quite unprecedented at so early a date. The growth of membership in all classes has been considerable, the recent applications creating a new record. A number of manufacturing companies have applied for membership in the association for the purpose of securing exhibit space at the next convention.

The Insulating Cost in the Manufacture of Dynamo-Electric Machinery.

Some interesting graphical data are given in the London *Electrical Engineer,* February 16, by Mr. H. M. Hobart which show the relative costs for the different processes in the manufacture of electrical machinery, particularly with respect to the cost of insulation. Mr. Hobart divides the subject into several parts, showing first the cost of insulating the commutator, next the cost of insulating the armature of direct and alternating-current machines. Finally the cost of the field insulation is taken up for direct and for alternating-current machines. Curves are given, showing the variation in the cost of each of these factors for machines of different types, and also for the total cost of constructing each part of the machine. Machines varying in output from 200 or 300 to 4,000 kilowatts, and in voltage from 500 to 12,000 are discussed. In order to avoid unduly complicating the subject certain assumptions are made, but it is believed that these do not affect the result essentially. For example, the cost of commutator insulation varies from thirty-five per cent of the total insulating cost in small machines up to fifty per cent in large machines. These costs are for the insulation in form ready for use. No attempt is made to consider the cost of manufacturing the finished insulation from the raw materials. Also, the labor for insulating the field spools is so closely associated with that of winding them that they can not be separated, so that the total cost for this is charged against insulation. It is found that the cost of commutator insulation is generally between seventy-five cents and $1 per square decimetre of peripheral surface of the commutator. This value tends to be higher in 500-volt machines and lower in 100-volt. It also decreases slightly with increasing size of commutator. The cost of commutator insulation is generally between two and four per cent of the total shop cost of the machine. Although the price of labor varies considerably in different countries, it has been found that the most expensive labor generally gives the cheapest work, but the difference is so small that the figures for one country can be used with close approximation to obtain results in other countries. These data are given in various forms, one set of diagrams showing the cost of material, labor and other manufacturing charges in percentage of the total cost of the machine. Another set shows the cost of insulating the armature in terms of the weight of armature copper; another a similar set of curves for estimating the insulating costs of both armatures and fields in terms of the weight of the copper. Examples are given, showing how these curves may be used to determine the best design of a machine for any particular case. For example, it is found that if the insulating cost of the machine is not to be more than five per cent of the total shop cost, a machine for 3,000 volts can not be constructed for over 200 kilowatts, while a machine for 12,000 volts could be as large as 2,000 kilowatts.

The Chesapeake & Potomac Telephone Company.

The report of the board of directors to the stockholders of the Chesapeake & Potomac Telephone Company for the year ended December 31, 1905, shows a total revenue of $1,953,735.11. There were total expenses of $1,464,545.74. The net earnings were $489,189.37. The interest charges were $281,169.28, and $147,160.21 was charged to depreciation. The credit balance to surplus was $60,859.88. Substantial progress was made during the year in reconstructing the plant throughout the territory. The company has begun construction on a nine-story, fireproof building on Light street, in Baltimore. In this building a new exchange, to be known as St. Paul, will be installed to replace that destroyed by the fire of February 7 and 8, 1904. A building on Walbrook avenue, in which the Walbrook exchange will be located, has been purchased. The underground plant in Baltimore has been largely extended. It is purposed to continue this work during 1906, extending the underground system and removing overhead wires in various parts of the city. Similar work has been carried on in Washington, about thirty-eight miles of duct having been constructed, and the overhead lines removed or greatly reduced in number.

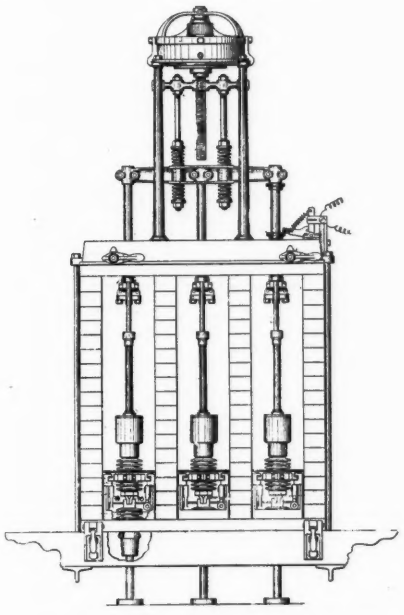
Various modifications of charges for service in Baltimore, Washington and other parts of the territory have been made during the year, one of which was the reduction of rate for measured service private branch exchange stations from $12 to $6 per annum. Much construction and reconstruction work has been done in the company's territory outside of Baltimore and Washington. This includes all of Maryland lying west of Chesapeake bay and the counties of Jefferson, Berkeley, Morgan, Hampstead, Mineral, Grant and Hardy in West Virginia. Exchanges were opened at eighteen towns, and approximately 500 miles of line connecting some 1,500 farmers' stations were constructed. A fireproof building specially arranged to meet the company's needs was erected at Annapolis, and a suitable building was purchased at Hagerstown.

Explosion Due to Radium.

A brief account is given in the *Physikalische Zeitschrift* (Leipsic), January 15, of a severe explosion of a glass tube containing twenty-five milligrammes of the purest radium bromide which was being studied by Herr Julius Precht. The radium salt was contained in a small tube two millimetres in diameter, and with walls one-half millimetre thick. The salt first had been heated for a long time at 150 degrees centigrade in order to drive off part of the water of crystallization. It was in a finely pulverized state. The tube was sealed up on December 27, 1904, and since that time it had been used for many measurements in an ice calorimeter, and toward the end of November of last year it was submerged a number of times in liquid air, and then brought again to the temperature of the room. This was done without any accident until after the seventh immersion. Then the tube suddenly exploded with a loud noise after it had been laid upon a wooden table for three minutes. The shock of the explosion was so great that glass in a neighboring mioroscope was broken, and the radium bromide was distributed widely throughout the room, practically none remaining upon the table. However, nearly all the fragments of the glass tube were found upon the table in close proximity to the point where the tube had rested. From these observations Herr Precht concludes the explosion was not due to strains induced in the glass tube on account of its rapid change in temperature. It must, therefore, have been due to pressure created in the tube by the radium, caused possibly by the liberation of the emanation or of helium which had been accumulating in the tube since it had been sealed. The dimensions of the tube show that the pressure required to shatter it was about twenty atmospheres, which must have been developed during the eleven months after the tube had been closed. A similar incident has been noted by E. Dorn, who stated that a large tube had exploded six months after sealing. Mme. Curie also made a note of the bursting of a glass tube two months after some radium salt had been sealed within it. The author has undertaken to investigate the matter thoroughly in order to determine the rate at which pressure is developed within a sealed tube. He publishes this note in order to call attention to the danger of explosion which may exist in tubes which have been sealed up for some time.

Electrical Patents.

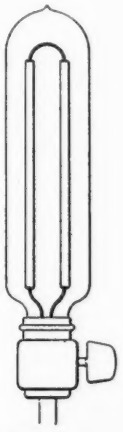
An improved switch or circuit-breaker for high-potential circuits has been invented by Edwin W. Rice, Jr., Schenectady, N. Y., and he has assigned it to



SWITCH OR CIRCUIT-BREAKER FOR HIGH-POTENTIAL CIRCUITS.

the General Electric Company (812,880, February 20). The invention relates to means for opening and closing circuits carrying currents of high potential and large amperage. An essential feature of the invention consists in enclosing the point of contact rupture within a small closed chamber, which may contain oil, air, or any other insulating medium, and by means of which the heat of the arc is utilized to reduce the cross-section of the arc stream by means of the rapid increase of pressure when the circuit opens, thereby permitting the arc to be ruptured by a shorter range of movement than otherwise. The improvements embody, also, means for operating the movable terminals without the presence of the operator in the immediate vicinity of the apparatus carrying the high-potential currents, thereby ensuring his safety in manipulating it. To this end is provided some type of motor by which the movable electrodes may be operated with means for controlling it at a distance from the switch or circuit-breaker. It has been found convenient for this purpose to employ an electrical control circuit, by which the closing and opening of the contact may be governed, and further increase the safety of the apparatus by employing multiple-pole contacts and separately enclosing each pair of contacts within insulating fireproof cells.

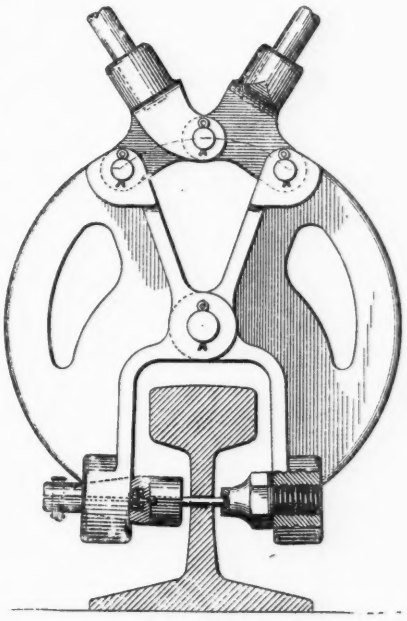
Herschel C. Parker, of New York, N. Y., has obtained a patent of the United States (812,872, February 20) on an improved incandescent electric lamp, assigning it to the Parker-Clark Electric Company, Jersey City, N. J. The invention relates to improvements in incandescent lamps, and particularly to that variety of incandescent lamps in which the incandescent body is contained in a protective tube, which is highly refractory and permeable to light, as opposed to that class of lamps in which an incandescing filament is contained in a vacuum or in which a tube, which is a non-conductor at low temperature and a conductor at high temperature, is used with an inside conductive coating to heat the tube to incandescence and make it conductive, or in which a tube is used having an inside coating and a gaseous inner conductor. An electric incandescent lamp, comprising a tube of highly refractory material which is permeable to light, a conducting film on the inner surface of the tube, a non-conducting packing filling the tube, except at points near the ends, a packing of a relatively good conductor at the tube



INCANDESCENT ELECTRIC LAMP.

ends, leading-in wires connecting with the conductive packing and a seal for the tube ends.

Fred C. Arey, of Chicago Heights, Ill., has obtained a patent (812,803, February 20) on an improved tool for bonding rails. The invention relates, in general, to implements for radially expanding a wire or rod by axial compression and more particularly to tools for uniting the terminals of bonds to railroad rails. The invention consists in the combination with a pair of pivotally united jaws spaced apart to straddle the head of the rail and extend downwardly, opposite a given point in the rail-web, of a pair of toggle links interposed between and operatively connected to said jaws, means for operating said toggle links to move the free ends of the jaws toward a common point in the rail-web, and means carried by the free ends of said jaws for rigidly engaging a wire at predetermined points.



TOOL FOR BONDING RAILS.

The Railway Signal Association.

The next meeting of the Railway Signal Association will be held at the Great Northern Hotel, Chicago, Ill., Monday, March 19, beginning at 10 A. M. sharp. It is expected that three sessions will be held.

At this meeting a new constitution and by-laws will be presented for adoption. Mr. F. B. Corey, railway engineering department, General Electric Company, Schenectady, N. Y., will read a paper entitled "Charging of Storage Batteries from Alternating-Current Circuits." Mr. W. N. Spangler, supervisor of signals, West Jersey & Sea Shore Railroad, will read a paper entitled "Substituting Track Circuits for Detector Bars." Mr. W. A. D. Short, signal engineer of the Illinois Central Railroad, will read a paper entitled "Power-Operated Distant Signals."

The secretary of the association is Mr. H. S. Balliet, 335 Madison avenue, New York city.

Reviews of Current Engineering and Scientific Literature.

The Mansfield, England, Electrical Undertaking.

An interesting feature of the municipal electric light and power plant of Mansfield, England, is the installation of refuse destructors in an adjoining building, the steam from which is delivered to the generating station. Mansfield has a population of 28,000 inhabitants. The destructor plant is designed to destroy 200 tons of refuse per week, which is delivered to it by the street cleaning department. The destructor of the plant consists of three twin cells of the back-feed type, provided with a hot fan draught. The refuse is tipped into a hopper behind the furnaces and is raked on to the latter from the clinkering floor in front. The twin cells are separated by a low central wall and are fired alternately, the arrangement of flues being such that the gases rising from the furnace, which have been freshly charged, are thoroughly mixed with those from the adjoining cell, thus producing complete combustion and maintaining a high temperature. The gases from these cells are passed under Babcock & Wilcox boilers, each of which has 1,200 feet of heating surface, and under the present conditions easily provide steam for a load of 200 kilowatts. The fans for the hot blast are motor-driven and discharge air through a heater in the flues to the under side of the destructor gases. The boiler house proper of the plant adjoins the destructor house and contains three boilers of the Lancashire type. These use a cheap grade of fuel. The engine room contains three generating sets, two consisting of triple-expansion engines direct-connected to 240-kilowatt, four-pole, compound-wound dynamos. The third set possesses some novel features. The generator is provided with commutating poles and the engine is fitted with inclined receivers. A storage battery with a rating of 1,000 ampere-hours is used in conjunction with the generators. The plant supplies current for lighting the town and also for the local street railway.—*Abstracted from the Electrical Review (London), February* 16.

The Critical Velocity and Balancing of Steam Turbines.

The introduction of high-speed prime movers has made the question of balancing the rotating parts of them and of the generators of great importance. In this section of a serial on the design and construction of steam turbines, Mr. Frank Foster discusses the critical velocity of turbine rotors and the methods of balancing them. The critical speed of the rotor corresponds exactly with the natural frequency of transverse vibrations of the rotor, so that in order to determine the critical speed, all that is required is to determine, experimentally or otherwise, the frequency of transverse vibration of the rotor. This is done analytically and a formula deduced giving the critical velocity in terms of the constants of the machine. When the rotating part consists of a wheel mounted on a uniform shaft, an approximate result can be obtained by adding to the wheel a weight equivalent to 0.6 of the weight of the shaft and then computing the period of vibration. A more accurate method has been given by Dunkerly, who suggests the following empirical formula:

$$N = \frac{N_1 \times N_2}{\sqrt{N_1^2 + N_2^2}}$$

in which N is the critical velocity of the combination and N_1 and N_2 the critical velocities of the two parts. This formula can be extended to three or more parts. In turbines of the action type the critical speed is usually from one-sixth to one-eighth of the running speed, and turbines of this type should be started as rapidly as possible, in order to pass this point quickly; hence they should be started unloaded. The critical speed of reaction turbines should always be considerably higher than the normal running speed, since these machines have but small radial clearance; hence the rotor of such machines can not be mounted on a slender shaft. The author then considers the more general case where the shaft is not of uniform diameter and the loads are not evenly distributed. He also discusses higher critical speeds and describes the method of procedure in balancing. To assist in securing a good balance the rotor should be accurately machined all over and the materials used should be homogeneous. In any case, however, it is necessary to balance the rotor experimentally. Where the rotor consists of a central drum or shaft bearing several independent wheels, these should be balanced separately, for it is not sufficient in balancing a rotor to bring its centre of gravity into the axis of rotation. There must, in addition, be no unbalanced couple due to rotating masses. In practice the rotor should be balanced statically on parallel ways or, better, by means of an arbor with knife edges in its axis. For a rotating balance the parts should be revolved and a piece of chalk brought close up to the shaft while it is running. The side of the shaft which pulls out will receive a slight mark which, according to London, is usually from fifty to ninety degrees ahead of the out-of-balance mass. At very high speeds it is directly opposite. The rotor is then run in the opposite direction and a second mark obtained. The out-of-balance mass will then lie midway between the two marks. Statical balance of the rotor of a Parsons turbine is said to take from one to six days. Balancing of the generator field is quite as difficult, and, unlike the turbine rotor, the field may come out of balance when running slowly, owing to the shifting of some of its wiring.—*Abstracted from the Mechanical Engineer (London), February* 17.

Electric Railway Engineering.

Improved methods of railway-motor construction are discussed in this article by Mr. J. E. Webster. Recent improvements in railway motors have been made for the purpose of increasing their reliability rather than their electrical efficiency, which allows of but little improvement. Careful and extended observations have been made to determine any points of weakness in material and design. As a result, the intervals between inspections necessary for safe operation have been greatly increased and the number of cars out of order decreased. Three years ago the intervals between inspections varied from 8,000 to 15,000 miles, or from one to three months on a time basis. To-day it is not unusual to have motors of the latest design in service for a year or more and to have them run 50,000 to 75,000 miles without overhauling. Having eliminated so much of the trouble which calls for inspection, rigidity of construction becomes of the first importance and accessibility secondary except as regards lubrication. The wear of bearings in the older types of motor determined, to a great extent, the number of inspections. By the introduction of oil and waste as a means of lubrication, in place of grease, the life of bearings has been so increased that this is no longer the controlling element. With respect to their size, railway motors may be divided into two groups: those below

eighty horse-power comprising the type used on city and smaller interurban cars, and those above eighty horse-power, which are used on heavy interurban, elevated and subway service. The principal reason for this grouping is the fact that with the smaller motors there is sufficient room between the car wheels and below the car body to allow the design of the motor to be unaffected by space limitations. The armatures are also sufficiently light to be conveniently handled from below the car in a pit. The motors of the largest type are so heavy as to make the use of a hoist or crane necessary in handling, and the long armatures make necessary the use of separate housings or bearing-heads extending well inside the commutator and rear armature winding, in order to get sufficient length of bearing. Motors of the small type are split horizontally, and hence the poles are placed at an angle of forty-five degrees from the horizontal. Motors of the larger type are either split diagonally, and hence have poles horizontal and vertical, or else are of the box type, the frame being in one piece and the armature inserted from one side. To secure a rigid armature, two types of construction are employed. The older method is to assemble the commutator, the armature heads and the laminations separately on the shaft, and to press them into position from the commutator end and hold them in place by a heavy nut in front of the commutator. A more recent construction is to provide a one-piece spider or quill, upon which all parts of the armature are built. This quill is then pressed upon and keyed to the shaft. A large commutator consisting of a large number of bars must be used in order to keep down the temperature. Ventilation, while it reduces the temperature of the motor under a given load, introduces dust into the machine, which is likely to injure the insulation, hence it is better to provide ventilating ducts, which prevent the air coming in contact with the insulation. In some designs the motor is sealed up and no ventilation is provided, but although this avoids the dust trouble, it reduces the rating of the motor. For wire-wound armatures cotton insulation is customary, and not much is gained by an asbestos tape placed around it. Where a bar winding can be employed a mica tape forms a good construction. The considerations in laying out a bearing for oil lubrication are so to shape the waste reservoir that the waste can not fall away from the journal; and, second, to provide for carrying and measuring the oil supply below the lowest point of contact of the waste within the shaft. With the proper shape and size of waste reservoirs a small quantity of oil only is needed to give good lubrication. Bearings lubricated in this way show but slight wear after a year's service.—*Abstracted from the Electric Journal (Pittsburg), February.*

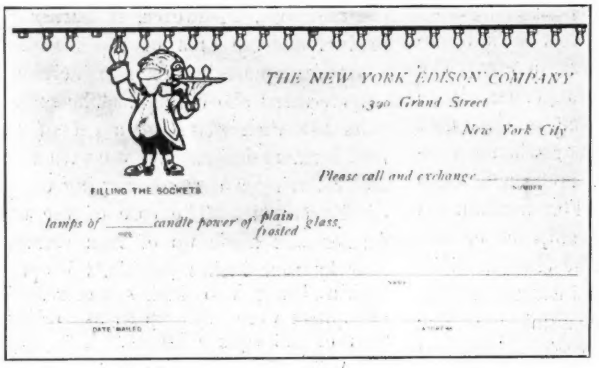
Series Transformers for Wattmeters.

Alternating-current wattmeters and ammeters for currents of 100 amperes and upwards are usually supplied with series transformers. In this article Mr. L. W. Wild discusses the design of such transformers for use with wattmeters. The main object of this arrangement is to avoid the large errors due to the effect of eddy currents that occur when a conductor of large section is brought into the instrument itself. For instruments having a range of 200 amperes or less these eddy currents can be eliminated by winding the coils of the instrument with a cable consisting of a number of fine wires insulated from each other and stranded so that each wire occupies in its course every position in turn with regard to the central axis of the cable. For heavier currents this method of stranding becomes impracticable. He first calls attention to the errors arising from the use of heavy copper strip coils in the wattmeter. With an instrument giving correct readings with direct current, a slight error occurs with alternating currents of unity power-factor, and this increases usually with a decrease in the power-factor. Sometimes the error amounts to over seven per cent. When a series transformer is employed, the transformer must be carefully designed to obtain good results. The current ratio should be as nearly as possible equal to the winding ratio, and the phase difference between the primary and secondary currents should be as small as possible. This result must be obtained by reducing the core loss and magnetizing currents to a minimum and by paying very careful attention to the question of magnetic leakage. The latter point is of the utmost importance. A test was made to demonstrate this by means of a transformer of the core type with four coils arranged so that the primary and secondary coils could be grouped on the same or on opposite legs of the core. When one primary and one secondary coil were placed on each leg, the error was small with unity power-factor and was only one per cent with a power-factor of 0.5. Arranging the primary and secondary coils on opposite legs gave an error of four and one-half per cent at unity power-factor and seven and one-half with a power-factor of 0.5. The difference in accuracy is due entirely to magnetic leakage, which operates by causing the secondary current to lag behind the transformer volts, thus bringing it more nearly into phase with the magnetizing current, and secondly, by increasing the transformer volts. In order to avoid this error the ampere-turns should be large and the magnetic reluctance small. The volts per turn should be as small as possible. These requirements are contradictory. However, it hardly pays to increase the area of the iron much above one square inch, nor to increase the ampere-turns above 1,000. The same results are then given of a set of three transformers designed for use with a wattmeter having a current-carrying capacity of one ampere. The core of the transformer was made up of iron stampings four by four inches outside, the opening within being two inches square. The stampings were built up so as to give an area of 1.3 square inches. The secondary winding consisted of two coils of 500 turns each, one on each side of the core. Three arrangements of primary windings were used: one consisting of fifty turns of No. 14 wire, having a range of ten amperes; another consisting of five turns of one and one-half-inch by 0.028 copper strip, giving a range up to 100 amperes; the third, one turn bent in an S-shape around the two secondary windings, giving a range up to 1,000 amperes. The transformers complete weighed seven pounds, and it was found that the magnetic leakage was entirely negligible. The tests made with these transformers showed that with a frequency of fifty cycles per second and a power-factor of unity that the core loss error was 0.4 per cent and the magnetizing current error was negligible, giving a net error of 0.4 per cent. With a power-factor of 0.5, the magnetizing current error was 1.4 per cent high, the core loss error, as before, 0.4 per cent low, the net error being one per cent. With a frequency of 100 cycles per second and unity power-factor, the core loss error was 0.2 per cent low, the magnetizing current error, as before, negligible, leaving a net error of 0.2 per cent low. With a power-factor of 0.5, the magnetizing current error was 0.9 per cent high, leaving a net error of 0.7. With a power-factor of 0.25 and a frequency of fifty cycles, the net error was 2.6 per cent high. With a frequency of 100 and the same power-factor, the net error was 1.8 per cent high. Curves showing the hysteresis and eddy-current loss and the magnetizing current loss for different frequencies are given. These show that the core loss increases as about the 2.7 power of the maximum induction for values varying from 200 to 400 lines per square centimetre. This result does not agree with the Steinmetz rule.—*Abstracted from the Electrician (London), February 16.*

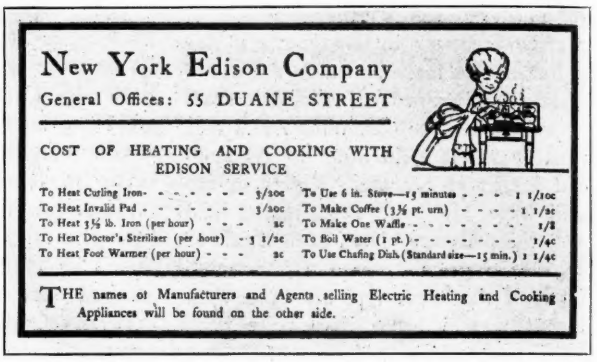
Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The New York Edison Company has recently distributed some attractive and valuable literature. One folder which has been of considerable utility, and which has been distributed in various forms, comprises a list of charging stations. This gives the name, street number and telephone number of forty-odd charging stations, the addresses being classified into districts. The cover design is made up of a number of automobiles of various kinds. The accompanying illustration shows a postal-card which the Edison company is making use of, distributing these to its customers so that the data received, regarding renewal of lamps, may be concise and correct. These postal-cards are printed on different colored stock, according to the district in which they are circulated.

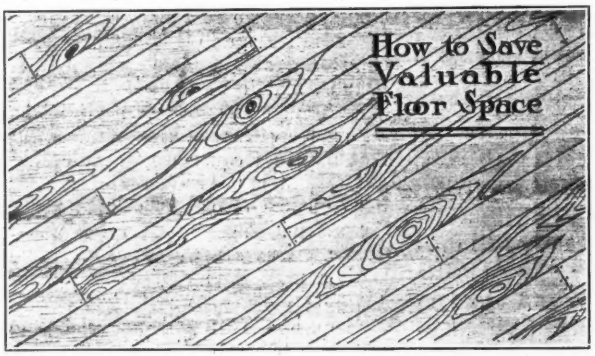


Postal Call for Renewals. New York Edison Company.


New York Edison Company
General Offices: 55 DUANE STREET
COST OF HEATING AND COOKING WITH EDISON SERVICE
To Heat Curling Iron- - - - - - - - 3/20c
To Heat Invalid Pad - - - - - - - - 3/20c
To Heat 3½ lb. Iron (per hour) - - - 2c
To Heat Doctor's Steriliser (per hour) - 3 1/2c
To Heat Foot Warmer (per hour) - - - 2c
To Use 6 in. Stove—15 minutes - - - 1 1/20c
To Make Coffee (3½ pt. urn) - - - - 1 1/2c
To Make One Waffle - - - - - - - - 1/2
To Boil Water (1 pt.) - - - - - - - - 1/4c
To Use Chafing Dish (Standard size—15 min.) 1 1/4c
THE names of Manufacturers and Agents selling Electric Heating and Cooking Appliances will be found on the other side.

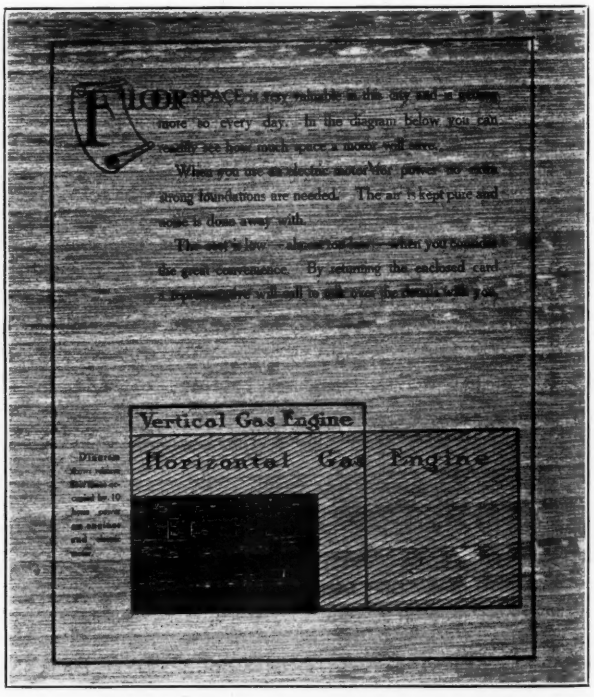
A Very Attractive Cost-Card from the New York Edison Company.

It takes the type well, and, as may be seen from the illustration, the text is just as readable as if printed on a smooth-cut paper. The color scheme was black and flat brick red, and the circular measured three and one-half inches by six inches.



A Folder in Wood Veneer from the New York Edison Company.

Another very attractive circular which the New York Edison Company recently sent to a selected list of power users was printed upon very thin wood veneer. A



The Folder in Wood Veneer Opened Up.

Another attractive card which the New York Edison Company has been distributing is reproduced herewith. This is a cost-card of heating and cooking with the Edison service. On the reverse side the names of manufacturers and agents selling electric-heating and cooking appliances are found. There has been a considerable demand for this cost-card, and the impetus it has given to the use of current and the sale of these appliances has been noticeable.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Single-Phase Alternating-Current Equipment for Milwaukee Electric Railway and Light Company.

The advantages attending the use of alternating current for the peculiar operating conditions of interurban trolley lines are again emphasized by the announcement that another company is about to install this system. In the South and West, where long-distance trolley lines with few stops are more numerous than in the more thickly settled eastern portions of the United States, the alternating-current system has been successfully adopted by several companies, and the latest to decide upon this method is the Milwaukee Electric Railway and Light Company, Milwaukee, Wis. This company is about to equip two suburban extensions of its lines with the alternating-current apparatus manufactured by the General Electric Company, of Schenectady, N. Y. One of these lines will extend from Waukesha to Oconomowoc, a distance of twenty miles, and the second will operate between Hale's Corners to Mukwonago, a distance of sixteen miles. Both lines will be operated at a potential of 3,300 volts, and in addition the motors are designed to run on the existing seven miles of 550-volt direct trolley line between West Allis and Milwaukee.

GENERAL ELECTRIC ALTERNATING-CURRENT RAILWAY MOTOR.

The motors to be furnished for this equipment are the standard General Electric alternating type, shown in the illustration. Each of the ten cars comprising the initial equipment for the road will be furnished with four motors of seventy-five horse-power each, known as the GEA-605. These are of the compensated type, comprising an armature similar to the ordinary standard direct-current bar-wound form with mica insulated coils. The motor fields consist of laminated pole-pieces, over which are slipped the spools of the exciting winding; the compensating winding consists of a bar winding inserted in the pole faces and permanently connected in series with the armature winding. The seventy-five-horse-power motor is wound for four poles, and has a maximum speed of about 140 revolutions per minute.

These equipments will, in general, be operated as single cars, but occasionally will be run in two-car trains. For the flexible control of these train combinations, the well-known Sprague-General Electric system of multiple unit control will be used, adapted for operation on alternating current. Further details of this interesting adaptation of the system, which has been so widely used for direct-current work, will be published later.

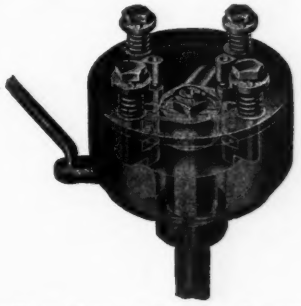
The compensator for use in these cars is of the oil-cooled type and is wound for 3,300 volts on the primary, with five different secondary taps for controlling the speed of the motor. In order that the acceleration may be smooth, special devices are employed, so that there will be no break in the circuit from one tap to the next during a change in speed. The speed-regulation is so devised that the running speed will be the same on both the alternating and direct-current portions of the line.

Distribution of the various transformer substations on this line will be at 33,000 volts. At the stations the current will be fed to the trolley line at 3,300 volts. For this latter the General Electric catenary construction will be used. It is proposed to have this line in operation during the fall of 1906.

The Crouse-Hinds Double-Ball Contact Commutator.

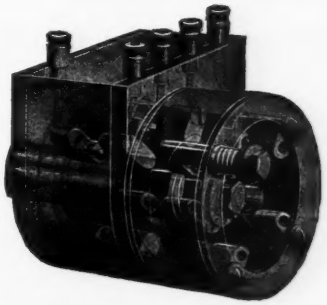
The Crouse-Hinds Company, Syracuse, N. Y., has placed on the market a new form of commutator and distributor for automobile, marine and stationary engines. With this commutator the contact is made by means of a cam passing between two steel balls held together by coiled springs. This ensures a positive contact, because the balls touch each other and must come in contact with the cam as the latter passes between them.

The cam is a solid piece with no movable parts. The movable parts are on the contacts, consisting of the two steel balls and the springs on each contact or the ball-carrier. With this commutator, where the movable parts are on the contacts, these parts move but once while the cam is making an entire revolution. When running at high speeds this is an important consideration, the cam having ample time to get back into place while passing from one contact to another. A long bearing on the shaft prevents the timer case from wabbling, ensuring accurate timing. The possibility of wobbling is also eliminated by the fact that there is no movable part on the cam to cause uneven wearing on the shaft bearing.



DOUBLE-BALL CONTACT PRIMARY COMMUTATOR OR TIMER.

The cam and ball-carriers are made of hardened steel, while the balls are especially selected for size, shape and quality. The shaft is made of high-grade machinery steel, and travels in a brass bearing which is lubricated by a small grease cup. The cam is secured to the end of the shaft by a nut and is carefully pinned to prevent its turning on the shaft. Like all other parts of the commutator, the cam may be easily removed and is readily interchangeable.



DOUBLE-BALL CONTACT SECONDARY DISTRIBUTOR.

The case is made of a special hard rubber, which resists moisture, oil and heat, and is a good non-conductor of electricity. A mica cover permits an inspection of

the interior, and at the same time keeps the working parts free from dirt. The balls on the contacts are fitted to turn readily in order to reduce to a minimum the wear on the cam, the ball-carriers and the balls themselves. As the timer is packed with grease, both the wear and the burning of the contacts are reduced to a minimum. The principle of the double-ball-contact distributor is exactly the same as that of the commutator. The distributor has two cams and two sets of ball contacts, one set for the timer and the other for the distributor, the only difference being that in the latter the balls in each contact are about three-eighths of an inch apart and the cam is insulated from the shaft. The connection is made and the circuit closed for each cylinder as the cam passes between the balls. As the circuit is closed in the distributor before it is closed in the commutator, and as it is broken first in the commutator, there is no possibility of the current following the cam when the latter leaves the contact in the distributor. Moreover, the possibility of the current jumping and firing the charge prematurely, or firing the wrong cylinder, is eliminated.

The terminals of the double-ball-contact commutators and distributors are constructed to permit ready insertion or removal of the wires and at the same time hold them securely in place. All parts are made of the best material, are interchangeable and easily replaced. The cams are constructed to make a quick break and to allow the commutator and distributor to run in either direction. The commutators and distributors are made for one, two, three, four and six cylinders, and for two and four-cycle engines.

$2,000,000 in Pension Allowances.

The statistics of the Pennsylvania Railroad pension department compiled up to December 31, 1905, show that during six years of its operation there has been authorized to be paid in pension allowances to the retired employés of the company the sum of $2,004,087.59. This expenditure does not include the expenses of operation of the department, which are also borne by the company. During the six years' application of the pension plan 2,700 employés have been retired as pensioners from the active service of the company, of which number 890 have died. Of the total number retired 688 were between the ages of sixty-five and sixty-nine years, of which 546 were retired on their own request, with the approval of the employing officer.

The Manufacture of Incandescent Lamps.

Very often an enquiry is raised with regard to the manufacture of incandescent lamps. From the earliest experiments the peculiar processes which are necessary in making up an incandescent lamp have been more or less a trade secret, and the work has been carried on behind locked doors in almost every case. Latterly, however, there has been a disposition to work more in the open and within the past few years there have appeared, from time to time, articles which gave a comprehensive idea of the manufacture of this device.

FIG. 1.—LAMP BULB AS IT COMES FROM GLASS MAKERS.

FIG. 2.—TUBULATED LAMP BULB.

FIG. 3.—TUBULATED BULB, BLOWN OFF AT NECK.

One of the most progressive manufacturers of incandescent lamps of to-day is the Brilliant Electric Company, Cleveland, Ohio. This company has thoroughly equipped a large factory for the manufacture of both tipped and tipless incandescent lamps, and, what is more, has practically opened wide the door for inspection and instruction. The series of illustrations given herewith shows in a measure why these lamps have attained such popularity in so short a space of time.

Fig. 1 shows the lamp bulb wrapped in tissue paper as it comes from the glass works. The necks of the bulbs are considerably longer than when the lamp is completed, and at this stage there is no tip at the wide end of the bulb. After unwrapping the bulbs are placed in racks and flushed out at the bulb-washing tables and carefully dried. When thoroughly dry a blowing-off machine, which revolves the bulb in gas jets under air pressure, takes off the elongated neck. According to whether the bulb is to be used in a tipped or tipless lamp, a slender piece of tube is attached to the wide end of the bulb. This is called tubulating the lamp. The appearance of the lamp after tubulating is shown in Fig. 2. Where the bulb is to be used for a tipless lamp it is not tubulated, the method of exhaustion being different in this case. Fig. 3 shows the tubulated bulb blown off at the neck.

The bulb has now progressed far enough in the manufacture of the lamp to be ready for the insertion of the filament. The processing of the filament is without doubt one of the most important features of lamp manufacture. The basis of the

FIG. 4.—SECTION OF FILAMENT ROOM AND LABORATORY.

incandescent lamp filament is a cellulose or gelatinous-like material made by dissolving chemically pure cotton in chloride of zinc. After the cellulose has been chemically processed by methods peculiar to each manufacturer, the mass is deposited in long glass retainers. Under air pressure the cellulose is forced through tiny platinum dies into a jar containing

alcohol, the jar revolving slowly, spiraling the thread-like filament and hardening or setting it. Fig. 4 shows a section of the filament room and laboratory.

After hardening the filament is removed from the alcohol and wound upon drums

FIG. 5.—OVAL-ANCHORED FILAMENT.

so that the alcohol may be evaporated from the fibre. When the thread has entirely dried it is cut into proper lengths and placed upon forms, which give to it the shape desired and the finished lamp.

Fig. 5 shows the oval-anchored filament

FIG. 6.—FILAMENT USED IN THE "BRILLIANT" TIPLESS LAMP.

as wound upon the form, and Fig. 6 the filament used in the "Brilliant" tipless lamp. After being wound upon the forms the filaments are taken to the carbon furnaces, a view of which is given in Fig. 7. In this furnace the filaments are subjected

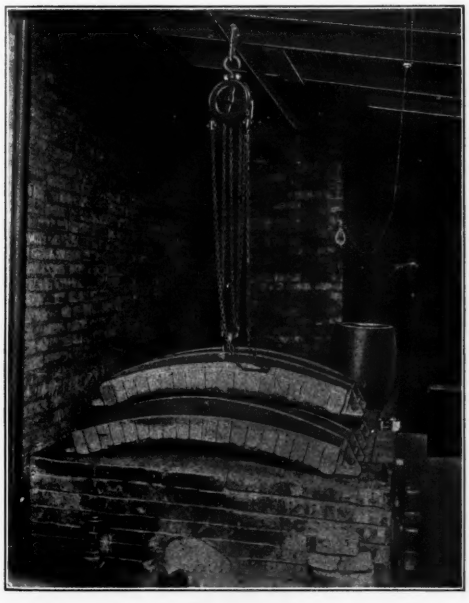


FIG. 7.—CARBON FURNACES FOR CARBONIZING THE CELLULOSE.

to an intense heat for a certain period of time and upon being withdrawn are found to be very much decreased in diameter, and instead of having a fibrous appearance appear to be converted into a metal with the characteristic lustre. During the heating the cellulose has been transformed into dense, hard carbon.

Certain infinitesimal irregularities in the filament require that it be subjected to a process called treating, which consists in placing the filament in a vessel

FIG. 8.—THE LEADING-IN WIRES.

which has been exhausted of air, and subjecting it to a bath of hydrocarbon vapor, the filament at the same time being raised to incandescence. The presence of the highly incandescent filament in a slowly circulating stream of gasoline vapor causes

FIG. 9.—FLANGED TUBE FOR TIPPED LAMP.

a deposit of carbon to form over those points in the filament which have a smaller diameter and consequently a greater resistance than the other points where the fall of potential is less. In this way the filament receives a deposit of carbon which makes its diameter uniform throughout its length.

A flanged tube has been prepared and the leading-in wires carefully sealed into this tube. The tube is heated at its unflanged end, and when the glass becomes sufficiently soft the sides are pressed together, sealing a short portion of both the copper and the platinum wires into the closed end of the tube. Fig. 8 shows the leading-in wires and Fig. 9 the flanged tube for the tipped lamp.

The next step in the process is clamping

FIG. 10.—THE MOUNT FOR THE TIPLESS LAMP.

or pasting the filament to the platinum tips of the leading-in wires. With a peculiar carbon paste the filament is cemented to the short platinum wires. This part of the process requires skill of the highest order, and only those artisans who have by long experience become expert in this work are engaged.

The flanged stem with its leading-in wires and filament already mounted is then inserted into the neck of the bulb until the flange in the neck of the tube

FIG. 11.—GLASS ROOM—SEALING-IN, STEM-MAKING, FLANGING AND TUBULATING.

is in contact with the flange on the neck of the bulb. The two pieces are then revolved so that the flames from several gas jets under air pressure impinge upon the junction of the two pieces, which are revolved until the glass softens, when an intimate union takes place, sealing the flange on the tube to the flange on the bulb.

The filament is now fastened securely in place in the lamp bulb, and the only place where air might enter is through the short piece of tubing which was attached to the bulb. As was noted above in the tipped lamp, this short length of tube is attached to the wide end of the lamp bulb. In the "Brilliant" tipless form of lamp

FIG. 12.—MOUNTING THE FILAMENTS.

the tubulating device forms a part of the mount; this is a distinctive feature, the exhausting tube usually being attached to the neck of the bulb. This is shown clearly in Fig. 10. Fig. 11 shows the sealing-in, stem-making, flanging and tu-

bulating departments, and Fig. 12 a view of the operatives mounting the filaments.

Next the lamps are pumped to procure as nearly perfect a vacuum as possible. A rubber hose leading to a mechanical vacuum pump is attached in the case of the tipped lamps to the stem which has been left at the end of the bulb, and in case of the "Brilliant" tipless lamps to the stem which forms a part of the mount. The mechanical air pump exhausts the air in the bulbs, and after sufficient attenuation has been secured, a small particle of a specially prepared phosphorus which has been introduced on the inside of the glass tube through which the exhaustion of air is taking place is heated by an outside gas jet. The fumes which result from heating of the phosphorus enter the lamp bulb, and at this moment the filament is suddenly raised to incandescence. The result is a chemical mingling of the phosphorus fumes and the attenuated air in the bulb, bringing on a reaction which entirely exhausts the traces of gas which may be left in the bulb. A brilliant and peculiar blue vapor fills the lamp bulb for a moment, and as the glow suddenly ceases the stem is heated with a blow torch, the air pressure from the outside immediately closing up the soft parts and sealing the bulb. With the tipped lamp all that remains of the stem through which the air has been exhausted is the slight protuberance with which all are familiar. In the case of the tipless lamp the tube from the mount is sealed off, the closed end being covered by the base when the lamp is assembled. Fig. 13 shows the tipped lamp ready for the base, Fig. 14 showing the "Brilliant" tipless lamp at this stage of the process.

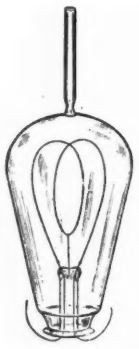


FIG. 13.—TIPPED LAMP READY FOR BASE.

FIG. 14.—"BRILLIANT" TIPLESS LAMP READY FOR BASE.

FIG. 15.—PHOTOMETER ROOM.

After this part of the process is completed the lamps are thoroughly inspected for mechanical defects and are then taken to the photometer room to be examined for their light-giving qualities. Fig. 15 gives a view of the photometer room. After being thoroughly tested in the photometer room the lamps are collected in trays holding fifty lamps each and stored in the lamp racks in the stock room. As the orders are received the lamps are withdrawn from stock and taken to the capping machine. Here the lamp bases are fastened by waterproof cement to the necks of the lamps. After the cement has hardened or set the lamps are taken to the soldering machine, where the copper wire terminals are soldered to their respective connections on the base. Fig. 16 shows the operatives soldering the connections to the base, Fig. 17 showing a completed lamp.

FIG. 16.—SOLDERING THE CONNECTIONS TO THE BASE.

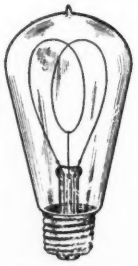


FIG. 17.—COMPLETED LAMP.

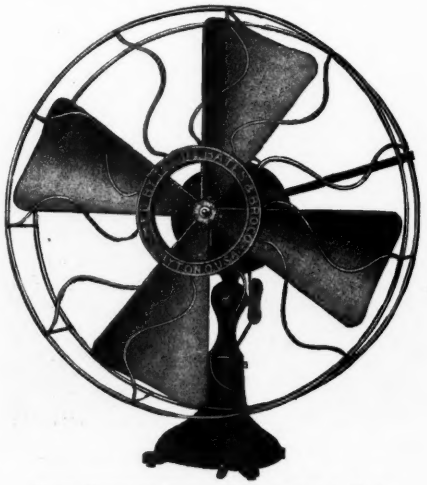
At this point the lamps are given a thorough test to discover whether there have developed any cracks or other mechanical defects, and also to make certain that a perfect vacuum has been maintained. The lamps are then labeled and turned over to the test racks, where they are given life and burning tests. After having satisfied all of the various tests the lamps are packed in cartons and crated for shipment.

A New "Universal" Fan.

A new "Universal" type of fan, which may be used for desk, wall or bracket service, has been designed and is now being marketed by the D. L. Bates & Brother Company, Dayton, Ohio.

It is said that this fan will be the largest made in this style of apparatus, as it will have twenty-inch blades. It will be finished in black enamel with guards and blades of brass.

In addition to this especial style the D. L. Bates & Brother Company manufactures a complete line of desk, wall and bracket fans, as well as the various ceiling types, for direct-current service. This company is one of the oldest manufacturers in America of electrical fan-motor apparatus.



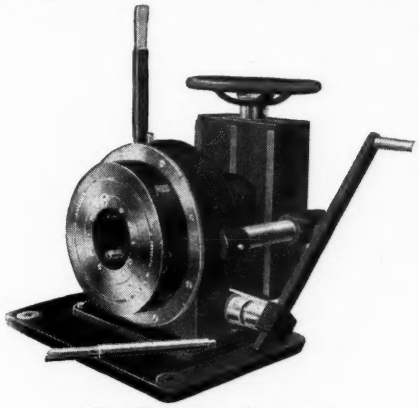
NEW TWENTY-INCH "UNIVERSAL" FAN.

The "Loew Victor" Pipe Machine.

The "Loew Victor" pipe machine, shown in the accompanying illustration is the result of wide experience in the use and manufacture of pipe-threading machinery, combining the valuable principles and recent improvements in machinery of this kind, with a view to saving labor and time.

The machine is solidly constructed of the best materials. The workmanship is of the highest grade, and the machine is designed to resist rough usage. Notwithstanding its solidity and strength, it is light enough to be conveniently portable.

Power is transmitted by a double-lead worm gear set close to the base of the machine, the worm gear having been found to be more powerful than bevel gears. By using a double-lead the speed maintained



PIPE-THREADING MACHINE.

is the same as if bevel gears were used. Sizes 2 and 3 of this machine are equipped with two outside gear wheels, which are encased in a guard, giving the machine two speeds—one high speed for smaller sizes of pipe, and a low speed for the larger sizes. For power purposes a direct-connected, three-step pulley and shaft are furnished, also a countershaft carrying a three-step pulley.

The dies, which consist of four pieces, are made of high-grade die steel, and when dull can be reground. This is an advantage, as it saves the time required to return the dies to the factory. The grinding does not change the shape of the cutting face of the dies.

Another important feature in connection with the dies in this machine is that during the operation of cutting the thread the pressure of the pipe against them prevents any possibility of their slipping.

No levers or locking devices are on the head of the machine and there are no projections on the face-plate. The face-plate adjusts the dies, which engage in a continuous scroll on the back of the plate. The plate is self-locking, requiring no bolts to lock the dies when adjusted to the desired size. Each machine is supplied with an oil-pan and tripod. The vise is a universal self-centering vise with two long bearing jaws made of tool steel. The pipe is clamped in the vise by a wheel which is of sufficient size to ensure the pipe being held perfectly rigid in the jaws when set.

On operating this machine the dies are set to the desired size, according to the graduations on the face-plate, shifting the plate backward or forward as necessary. The jaws of the vise are then opened by use of the handwheel. The pipe is inserted, the vise jaws being firmly clamped by the hand wheel, the hand lever is drawn toward the front of the machine, and the head revolved. This forces the pipe into the dies and starts the thread. After the thread is started the pipe feeds itself into the dies. When the thread is cut the dies are released by inserting the bars into one of the holes in the edge of the face-plate, opening it slowly, thereby taking the burrs off the thread. This quick-opening feature obviates the necessity of reversing the machine and backing the pipe out of the dies. This machine is made by the Loew Manufacturing Company, Cleveland, Ohio.

"Emerson" and "Trojan" Fans for 1906.

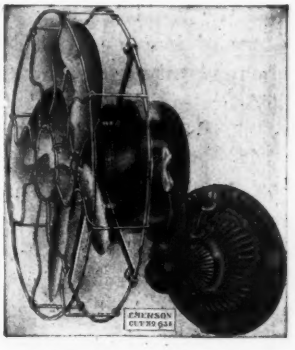
The Emerson Electric Manufacturing Company, St. Louis and New York, is offering an improved line of alternating desk and ceiling fans this season under the trade names "Emerson" and "Trojan," known heretofore. Both lines include automatic start, low-wattage desk fans and two and four-blade direct-connected ceiling fans, all operating on the simple induction principle, without brushes or commutator.

All types of desk fans made by this company are now equipped with new convertible base feature, by which any desk fan may be changed into a substantial bracket fan in a few seconds. No tools other than a small screwdriver are needed and no extra parts are required in making the change.

The appearance of the Emerson bracket fan, after the change, is shown herewith. All desk fans have two speeds, and a prompt start on either speed is obtained by the use of insulated phase coils, which are automatically disconnected when the motor reaches the proper speed.

New types of Emerson ceiling fans are equipped with indicating snap switch and speed coil, giving three distinct running speeds. The four-blade fan throws a strong breeze and is suitable for public places, while the two-blade throws a moderate breeze with the greatest speed regulation, being designed for smaller rooms or residences.

Both styles of Emerson ceiling fans are furnished with adjustable hangers, complete, and are wired for the attachment



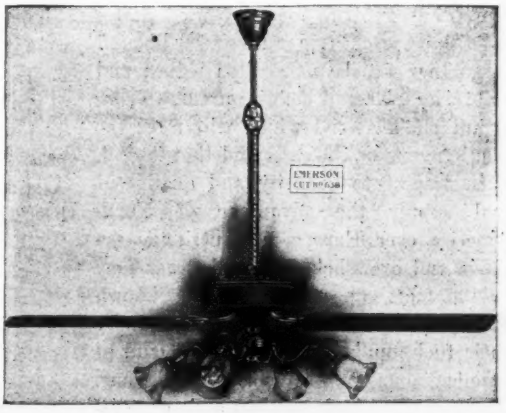
EMERSON ADJUSTABLE DESK OR BRACKET FAN.

of lights. Emerson ceiling fans are finished in a decorative oxidized copper.

"Trojan" ceiling fans, also made by the Emerson Electric Manufacturing Company, have only two speeds, are not provided with hangers and are finished in black japan. These motors are also wired for lights.

Lundin Electric and Machine Company.

The Lundin Electric and Machine Company has removed its main offices from 176 Federal street to 10 Thacher street,



EMERSON CEILING ELECTROLIER FAN.

Boston, in the same building with the factory. This is one of the finest appointed factory buildings in the East, being centrally located midway between the two large Union stations and having exceptional advantages which will enable the company to fill orders with greater despatch than formerly. The steady growth of the company's business has made this step necessary.

Production and Consumption of Coal and Iron.

According to a report from Consul-General Mason, of Paris, we are likely to run short in iron inside of a single century if we keep up the present rate of consumption. Yet we are more likely to increase the consumption than we are to reduce it. The world has only 10,000,000,000 tons of iron ore available. Of these Germany has twice as many tons as the United States. Russia and France each have 400,000,000 tons more than this country. Our consumption is placed at 35,000,000, which is more than a third of the world's total consumption.

Of the world's workable iron-ore deposits, as at present known, the United States possesses only about one-ninth, and at the present rate of consumption the entire supply will be exhausted within the present century. Therefore the future economic policy of American iron masters should be to secure, by all practical means, the largest possible ore supply from the mines of other countries.

The problem is largely one of transportation in which the item of marine freight rates plays a dominant part. An economic long-distance ocean rate for heavy, low-class merchandise, involves necessarily two conditions, viz., vessels specially adapted to the trade and return freights that will bear an equal or higher charge for transportation. The ship that brings ore from Spain, Sweden and other European countries to the United States must have each trip an eastward-bound cargo that will be more than ballast and yield a regular and definite profit. There is but one material which will meet the requirements of the case, and that is coal.

In respect to quantity and quality of coal supply the advantage of North America over European countries is decisive and overwhelming. Whatever may be the facts concerning ores, the known coal measures of the United States render their fuel supply secure, abundant and of excellent quality for centuries to come. There are hundreds of thousands of acres of gas and coking coals of high quality in the Appalachian region—to say nothing of other fields—which have as yet been hardly scratched by the pick and drill of the miner. New coal deposits of greater or less extent and value are being discovered from year to year. With what is now known the present enormous annual output of 280,000,000 tons of bituminous coal can be maintained for hundreds of years without exhausting the available supply. In Europe, on the contrary, the years of adequate coal provision are definitely numbered. In England experts estimate the duration of the workable coal measures to be from sixty to one hundred years. Germany has a somewhat longer lease of industrial life dependent on coal supply, but already the subject is so acute that a heavy contract for the delivery of German coal to France, for iron and steel works, is understood to have been canceled recently at heavy loss to the sellers, because, as it is definitely understood, the Imperial Government objected to the depletion of the national coal supply for the benefit of neighboring countries. France has native coal for a generation or more, but mines are deepening, the cost of production is gradually increasing, and economists are looking with growing apprehension to the future. Twenty-five or at most thirty years hence, the question of an adequate fuel supply will be a serious problem for France.

$1,000 in Prizes.

The Cooperative Electrical Development Association, Cleveland, Ohio, announces a competition open to all central station managers and their employés in the commercial department for the three best papers on the organization and conduct of a new business department suitable for central stations in cities of 50,000 population and under.

The first prize will be $500, the second prize $300 and the third prize $200.

The decision as to the winners will be left to a committee of three central station managers, to be appointed by the president of the National Electric Light Association. The winners will be announced and the papers distributed in booklet form at the Atlantic City meeting of the National Electric Light Association.

All papers, in quadruplicate, must be received on or before May 15, 1906, and the right is reserved to make use of them as may be to the advantage of all concerned.

Boiler Works Consolidation.

The Babcock & Wilcox Company, Bayonne, N. J., and the Stirling Consolidated Boiler Company, Barberton, Ohio, are arranging to consolidate with a capital of $15,000,000. This consolidation combines the largest and most modernly equipped boiler plants in the world. The Babcock & Wilcox Company's apparatus and the boilers of the Stirling Consolidated Boiler Company are well known. The products of these companies are installed in mechanical equipments in every part of the world. Last October the consolidation of the Stirling company, of Barberton, and the Aultman & Taylor Machinery Company, of Mansfield, Ohio, was announced. The consolidated company will, of course, be able to supply every type of water-tube boiler.

Pittsburg Reduction Company Takes Over St. Lawrence River Power Company.

The Pittsburg Reduction Company has taken over the St. Lawrence River Power Company, which owns a large water-power plant at Massena, N. Y. The Pittsburg Reduction Company is the chief producer of aluminum in the United States and has several reduction works, including a large plant at Massena. The reduction company is the principal customer of the power company, which also serves five to six other industrial establishments in the same neighborhood. The power company has outstanding, in addition to $500,000 five per cent bonds, $3,500,000 of preferred stock and $3,000,000 of common stock. The company has been taken over by the Pittsburg Reduction Company on the basis of an issue of $4,000,000 four per cent Pittsburg Reduction Company bonds in exchange for all the capital stock of the power company. The reduction company moreover guarantees the principal and interest of the $500,000 St. Lawrence River Power Company bonds.

The water-power plant at Massena, which is served by a canal from the St. Lawrence river, was built largely with English funds, an English syndicate holding seventy-five per cent of the St. Lawrence River Power Company securities. The plant has been in operation for several years, but great difficulty has been experienced each winter because of the frazile ice gathering in the canal, at times almost cutting off the flow of water. Plans have been prepared to obviate this difficulty, but to put these in execution would require a heavy additional expenditure, and the power company has preferred to sell out to the Pittsburg Reduction Company rather than to undertake itself the expense of additions. The present development—35,000 horse-power—will very likely be increased.

The directors of the St. Lawrence River Power Company are T. A. Gillespie, Mark P. Cox, William J. Wilson, H. B. Davison, E. C. Converse, Edgar Park and S. E. Potter.

Mr. R. B. Mellon, Pittsburg, Pa., is president of the Pittsburg Reduction Company, and the company is largely composed of Pittsburg capitalists.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

CAR FACTORY MERGER GIVEN UP—According to a statement made on Friday of last week by Kean, Van Cortlandt & Company, New York city, the managers of the syndicate which was to underwrite the consolidation or proposed merger of the leading street car plants of the country, the plan has been definitely abandoned. The syndicate obtained options on eighteen of the largest car-building plants and these options expired on the day mentioned.

WORK ON THE ELECTRIFICATION OF THE NEW HAVEN ROAD BEGUN—Work has been started at Mount Vernon, N. Y., on the electrification of the main line of the New York, New Haven & Hartford Railroad from Woodlawn, N. Y., to Stamford, Ct. The first step will be to lower the tracks about four and one-half feet, so that electric motor cars can pass under the overhead bridges. A new signal service will also be established for the third-rail system.

MISSOURI ELECTRIC RAILWAYS CONSOLIDATE—The stockholders of the Alton, Granite City & St. Louis Electric Railway Company and those of the St. Louis & Suburban Electric Railway have signed a preliminary agreement for the consolidation of the properties of the two companies. The merged companies are to constitute a $14,000,000 corporation. The merged lines will connect twenty-one towns with a population of about 100,000 and with about 175 miles of track.

CHICAGO ALDERMEN OFFER SEVERE TERMS TO CHICAGO TELEPHONE COMPANY—The board of aldermen of the city of Chicago, Ill., has demanded of the Chicago Telephone Company the payment of $350,000 to the city as compensation and the abandonment of all legal proceedings which might tend to embarrass the municipality. The demand was made at the meeting of the council committee on gas, oil and electric light and the company's representatives on February 20.

VANDERBILT TROLLEY PROJECT—It is understood that Vanderbilt interests are behind a project to link trolley lines in northern Indiana and southern Michigan, and extend the third-rail system to the places reached by interurban lines. The plan is to run cars from South Bend, Ind., to Niles, Mich., over the Michigan Central, over the Big Four into Benton Harbor, over the Indiana, Illinois & Iowa to St. Joseph, Mich., over the Lake Shore temporarily from Elkhart to La Porte, Ind., and over the Lake Erie & Western into Michigan City, Ind.

PENNSYLVANIA RAILROAD ORDERS MORE ELECTRIC CARS—The Wason Car Manufacturing Company, Springfield, Mass., has received an order from the Pennsylvania Railroad Company for eleven large electric cars to be used on the line between Atlantic City and Camden, N. J. The contract calls for five electric passenger cars and six mail and baggage cars built on the same plan as the cars previously ordered, and reference to which has been made in these columns. This is a $75,000 order, and is the second from the railroad in a few months.

KENTUCKY TELEPHONE DEAL—The Central Telephone Company has been organized to take over the Louisville independent long-distance and all smaller companies in Owensboro, Lexington, Maysville, Paris, Eminence and sections near these points in Kentucky. Southern Indiana will also be included. The Central Telephone Company was recently incorporated in the state of Delaware with a capital stock of $10,000,000. E. L. Barber, who was identified with the building of the Louisville Home Telephone Company, is president of the new company.

NEW CALIFORNIA POWER COMPANY—Articles of incorporation of the Battle Creek Power Company have been filed at Red Bluff, Cal. The directors of the company are Henry W. Brown and Walter E. Carr, of Colma, Cal., and Harold L. Wright, Dudley C. Bates and Joseph E. Barry, of San Francisco. The company is capitalized at $1,000,000, and its object is to furnish electric power and water. Since it became settled that the electric roads at Oroville and Chico will be completed, and that surveys are now being made between Red Bluff and Redding, several power companies have been formed, evidently with the idea of furnishing power to the railway concerns.

AMERICAN MACHINERY FOR TRACTION LINE IN PERU—An electric traction system using American electric apparatus and American railway materials entirely is to be built at Lima, Peru. The new line will cover thirty miles, and it is said will be in operation inside of twelve months. The present mule lines of the Compania Ferrocarriles Urbano de Lima are to be electrified and several miles of new track constructed. The contract for the entire work has been assumed by W. R. Grace & Company, of New York. The General Electric Company, Schenectady, N. Y., will furnish the electrical apparatus. Electric power for the lines will be generated at a hydroelectric installation thirty miles from Lima on the Rimac river.

CHICAGO SOUTHERN TRACTION COMPANY SPREADING ITS LINES—A new traction company has been incorporated at Springfield, Ill., with a capital stock of $1,500,000, by the same interests which are at the head of the Chicago Southern Traction Company. The road will be known as the Chicago, Blue Island & Joliet Traction Company. The Chicago Southern Traction Company some time ago purchased the old Chicago Electric Traction Company's line running from Sixty-third street and South Park avenue to Blue Island. The general scheme is to ultimately form a company to control a trolley line operating between Indianapolis and Chicago. The incorporation of the new company means an extension toward Indianapolis from Chicago.

INTERBOROUGH-METROPOLITAN MERGER PLAN DECLARED EFFECTIVE—The organization committee of the new traction merger company, of which E. J. Berwind is chairman, has formally declared the plan to consolidate the Metropolitan Street Railway Company, the Metropolitan Securities Company and the Interborough Rapid Transit Company to be effective. Further opportunity, up to March 16, is offered stockholders of the three companies, who have not already done so, to participate in the plan. The temporary board of directors of the Interborough-Metropolitan Company, composed of Walter G. Oakman, James Jourdan, John B. McDonald, Morton F. Plant and P. A. B. Widener, adopted resolutions accepting the plan and agreeing to issue that company's securities as provided thereby.

PUBLIC UTILITIES SOLD FOR LARGE SUM—Papers were signed at Davenport, Iowa, February 17, by which George J. Kobusch, of St. Louis, Mo., and eastern associates bought all the traction, electric light and power companies and gas concerns in the cities of Davenport, Iowa, and Rock Island and Moline, Ill., and an interurban line running from the three cities to Watertown, Ill. The purchase price is approximately $6,000,000. The transfer includes the Tri-City Railway Company, Davenport & Suburban Company, the People's Light Company and Davenport Gas and Electric Company, of Davenport; the People's Power Company, of Moline, and the Mississippi Valley Traction Company, which owns the interurban line. Most of the companies have franchises running from fifteen to twenty years.

NEW ELECTRIC LIGHT AND POWER COMPANY FOR NAPA, CAL.—A new electric light and power company has been organized in Napa, Cal., which will play an important part in the development of Lake and other counties. Articles of incorporation of the Cache Creek Electric Company have been filed. The new company intends to conduct a general business of generating and distributing electricity for light and power purposes, to purchase and handle water rights, to purchase and operate machinery, and to erect suitable buildings. The principal place of business is stated to be Napa, and the directors are as follows: E. H. Winship and R. Raymond, Napa, and F. W. Williams, San Francisco. The capital stock is placed at $1,000,000. Cache creek extends from Clear lake into Lake

county and Yolo county. The power-house will be built somewhere along the creek.

COLORADO TELEPHONE COMPANY TO EXTEND ITS LINES—The Colorado Telephone Company will spend between $1,400,000 and $1,800,000 in improvements to its lines in the Rocky mountain region during the coming year. This decision was arrived at at a meeting of the stockholders and the board of directors held in Denver, Col., on February 20. Part of the money will go into new buildings and improvements at exchanges now established, and a part will go into extensions into new territory. It is said that over $700,000 will be spent for new long-distance lines. The former board of directors was reelected, the old officers being reelected as follows: president and general manager, Edward B. Field; vice-president, Alonzo Burt; treasurer, Edward B. Field, Jr.; secretary and auditor, H. W. Bellard. The directors are Edward B. Field, W. L. Graham, A. V. Hunter, Philip Feldhauser, Crawford Hill, E. S. Kassler, Joel F. Vaile, Alonzo Burt and Frederick P. Fish. The Colorado Telephone Company has in use at this time 45,745 stations, a gain of 8,643 during the year.

AN EXTENSIVE NEW ENGLAND TRACTION MERGER—It is understood that negotiations are under way looking toward the consolidation of the Portsmouth, Dover & York Electric Railway with the Atlantic Shore Line. A special meeting was held on March 2 at Augusta, Me., for the purpose of voting on the proposed consolidation. The deal, if it is completed, will make possible an uninterrupted line of street railways from Portland, Me., to Boston, Mass. The plan of the railway officials is to connect the only gap between Portland and Boston. At the present time there is a stretch of eighteen miles between Kennebunkport and York Beach, Me., which is not connected by street railways. The Atlantic Shore Line, with thirty-eight miles of track, runs through Sanford and Springvale to Cape Porpoise, with branches to Biddeford and Kennebunkport. The Portsmouth, Dover & York road, with forty-two miles of track, runs from Portsmouth, N. H., to Dover, with a branch line to York Harbor and York Beach, and to South Berwick, with a connecting line between Dover and York Beach. With the consolidation of the two roads the holding company will have 100 miles of track.

NEW INCORPORATIONS.

AUGUSTA, ME.—International Clark Wireless Telegraph Company. $2,000,000.

INDIANAPOLIS, IND.—The Mutual Telephone Company, of Shipshewana, Ind. $5,000.

LINCOLN, NEB.—Nebraska Telephone Company. Increased from $3,000,000 to $5,000,000.

AUSTIN, TEX.—North Texas Telephone Company, of Pecan Gap, Delta county. Increased from $5,000 to $10,000.

GUTHRIE, OKLA.—The Cushing Telephone Company, of Cushing. $2,000. Incorporators: W. W. Maud and Robert Oder.

LINCOLN, NEB.—The Hickman Telephone Company. $6,000. Directors: Adam Brendle, C. H. Hempel and August Schmitte.

BROOKLYN, WIS.—Brooklyn Telephone Company. $10,000. Incorporators: E. O. Wheelock, A. Crahen and Josiah Millspaugh.

SPRINGFIELD, ILL.—Bond County Telephone Company, Greenville. $6,000. Directors: J. S. Bradford, E. E. Wise and George V. Weise.

ALBANY, N. Y.—The Lapeer Telephone Company. To build a line from Lapeer to connect with the Killawog line and with the Dryden system.

SPRINGFIELD, ILL.—Floraville Rural Telephone Company, Floraville. $1,000. Incorporators: L. I. Zimmerman, Philip Wirth and Louis Eckert.

SPRINGFIELD, ILL.—Farmers' Fountain Telephone Company, Waterloo. $10,000. Incorporators: Henry P. Stumpf, Henry J. Stumpf and Fred Schrader.

MADISON, WIS.—Osceola Farmers' Mutual Telephone Company, of Osceola, Polk county. $10,000. Incorporators: George A. Taylor, George F. Clark, L. Corey and O. E. Roese.

GUTHRIE, OKLA.—The Southern Canadian Telephone Company, of Noble. $1,000. Incorporators: C. F. Wantland, C. M. Hobaugh, E. L. Sheets, Isaac Graham and A. Filtner.

GUTHRIE, OKLA.—Crescent Telephone Company, of Crescent. $20,000. Directors: D. Harader, S. E. Shore, L. V. Laurence, J. H. Laurence and L. W. Rrasals, all of Crescent.

EATON, COL.—Eaton Water, Light and Power Company. $30,000. Directors: William Aitchinson, W. J. Farr, John McCarty, Harry D. McCutcheon and C. D. Eggleston.

INDIANAPOLIS, IND.—Waterloo Electric Light and Water Works Company, Waterloo, Dekalb county. $25,000. Directors: Charles A. Wilding, John Dreibelbiss and William J. Vesey.

MADISON, WIS.—Southern Wisconsin Power Company, Madison. To develop water power at Kilbourn. $1,500,000. Incorporators: P. L. Spooner, Magnus Swenson and E. J. B. Schubring.

MILWAUKEE, WIS.—The Chicago, Kenosha, Milwaukee & Lake Geneva Electric Railway Company, Kenosha. $50,000. Incorporators: James Cavanaugh, John L. Wattles and Benjamin O. Sturges.

PITTSBURG, PA.—The Allentown, Tamaqua & Ashland Railroad Company. To build a line from Allentown to Mahanoy City, a distance of fifty miles. $500,000. W. M. Lindsay, of Pittsburg, president.

TRENTON, N. J.—The Mercer Electrical Company. To generate and distribute electricity for light, heat and power. $100,000. Incorporators: Francis C. Lowthorp, Robert R. Volk and Margaret T. Simpson.

ALBANY, N. Y.—Sultepec Electric Light and Power Company, of Brooklyn. To do business outside the state. $200,000. Directors: Ashley T. Cole, Alexander Keogh, W. M. Park, R. J. Heisler, John L. Wells, Thomas L. Hughes, James R. Ford, Jr., Isaac M. Sutton and Ernest L. Dane, all of New York.

MINNEAPOLIS, MINN.—White Bear Lake Telephone Company, Starbuck. $8,000. Incorporators: R. M. Tessemm, H. L. Corder, J. E. Moin, J. C. Gorder, A. M. Mollan, Carl Lingren, O. Aslakson, White Bear; L. K. Rio, Starbuck; G. H. Kjorsate, H. O. Kirkewald, Minnewaska; F. H. Sylvester, E. Barsness, Walden.

TROY, N. Y.—East Springfield Telephone Company. To operate lines from Richfield Springs to Cherry Valley, and also to Cooperstown and along the Mohawk river, as well as to Sharon Springs. $10,000. Directors: Henry Rathbon, of Cooperstown, and S. A. Young, H. W. Young and O. R. Young, of East Springfield.

PORTLAND, ME.—West Penobscot Telephone and Telegraph Company. Organized at Corinna for the purpose of constructing, operating and maintaining telephone and telegraph lines between Corinna village and other villages in that section of Penobscot county. $10,000. Officers: president, C. L. Jones, of Corinna; treasurer, J. E. Grey, of Corinna.

ENGINEERING SOCIETY.

TORONTO BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—On Friday, March 9, a meeting of the Toronto branch of the American Institute of Electrical Engineers was held at the Engineers' Club, Toronto, and the Institute paper, "Self-Exciting Alternators," was abstracted by Professor Rosebrugh. The Toronto branch is to hold a meeting on Friday, March 23, at the School of Practical Science, Toronto, when Mr. C. H. Wright is to present a paper entitled "Suburban Railways."

LEGAL NOTE.

PERSON CHARGED WITH RECEIVING STOLEN ELECTRICAL GOODS CONVICTED—In the Criminal Court of Chicago, Cook county, on Thursday, March 1, the jury brought in a verdict of guilty in the case of the people *vs.* Ralph Lipsey, who was president of the Great Northern Metal Company, 61 West Van Buren street, Chicago, Ill. The penalty for the offence is imprisonment in the penitentiary for not less than one year or more than ten years. Lipsey was indicted for receiving stolen property, the jury finding that he had received and again disposed of four cases of key sockets which had previously been stolen from one of the large jobbing houses of Chicago. The jobbing houses have suffered more or less from petty thieving, as well as from graver acts of stealing, involving often goods of considerable value. The evidence in this case was prepared by Frederic P. Vose, Marquette Building, who assisted State Attorney James Barbour in the prosecution of the case.

ELECTRICAL SECURITIES.

From every quarter the announcement comes that last week was probably the dullest in stock market speculation for a considerable time. The price movements have been irregular and confused, with a general tendency in the downward direction. Although liquidation was fairly heavy in volume, it was scattered, encouraging the hope that this movement had about subsided, and that new ground was being established for a recurrence of the upward tendency. The market has apparently reached a stage where a recovery is due. The announcement of the government plans for aiding the money market in the shape of depositing $10,000,000 with the national banks, to be left there until July 10, had a favorable effect. While the amount is nowhere near large enough to help out very materially, still even this slight encouragement indicates the general solidity of the situation. The drop in the price of copper will be welcomed by the large buyers. The iron and steel trade is reported as improving, notably in the steel rail line and in steel for structural purposes. The record annual report of the Pennsylvania Railroad, showing about ten per cent earned on the stock, is a notable example of the generally prosperous condition of the country.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 3.

New York:	*Closing.*
Brooklyn Rapid Transit	80⅛
Consolidated Gas	154
General Electric	167¾
Interborough Rapid Transit	228⅝
Kings County Electric	200
Manhattan Elevated	157¾
Metropolitan Street Railway	116⅜
New York & New Jersey Telephone	154
Westinghouse Manufacturing Company	185

The income account of the Kings County Electric Light and Power Company for the year ending December 31, 1905, shows as follows: interest from investment on guaranteed fund and interest on bank deposit, $46,758; net earnings of Edison company for 1905 transferred under lease agreement, $437,871, a total of $484,629; dividends, $400,000, and legal expenses and damages, $10,000, leaving a net balance for the year of $74,629. At the annual meeting of the Kings County Electric Light and Power Company and the Edison Electric Illuminating Company, the following board of directors was elected for both companies: Frank Bailey, William Berri, A. N. Brady, N. F. Brady, Horace C. Duval, Walton Ferguson, W. W. Freeman, Bernard Gallagher, Hugh J. Grant, Seth L. Kenney, Thomas E. Murray, W. F. Sheehan and A. M. Young.

The comparative income statement of the Brooklyn Rapid Transit Company for the year ending December 31, 1905, follows: gross, $17,493,011; operating expenses, $10,078,923; net, $7,414,088; other income, $225,501, a total of $7,639,589; charges and taxes, $5,388,138; surplus for year, $2,251,451, which, added to the previous surplus of $2,127,236, makes the total surplus $4,378,687, as compared with $4,130,997 for 1904. Of this amount there were appropriated the following amounts: $1,746,000 for discount of bonds sold; $12,600 in adjustment of various accounts; $288,145 for additions and betterments, leaving a balance of $2,331,143. The total assets of the company as of December 31 amount to $126,087,382, and the liabilities to $123,756,239. The gross earnings of the company for January increased $211,000.

Boston:	*Closing.*
American Telephone and Telegraph	137¼
Edison Electric Illuminating	246
Massachusetts Electric	67
New England Telephone	135
Western Telephone and Telegraph preferred	90

The gross and net earnings of the Massachusetts Electric Companies continue to show steady increases and by reason of the open winter the operating expenses have been considerably below those of a year ago. The gross earnings for January and February combined show an increase of approximately $130,000 over the same two months of 1905. The net earnings increased about $150,000, showing a saving this year in operating expenses of $20,000. This is the best showing for these two winter months in the history of the company.

Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	79
Electric Storage Battery preferred	79
Philadelphia:	*Closing.*
Philadelphia Electric	8
Philadelphia Rapid Transit	31
United Gas Improvement	95
Chicago:	*Closing.*
Chicago Telephone	119
Chicago Edison Light	160
Metropolitan Elevated preferred	68
National Carbon common	92
National Carbon preferred	119
Union Traction common	11½
Union Traction preferred	44

The annual report of the National Carbon Company for the year ended January 31, 1906, has been issued. The income account is as follows: net earnings, $890,764; preferred dividends, $315,000, and common dividends, $192,500, leaving a balance of $383,264; charged off, depreciation, etc., $353,513, leaving a surplus for the year of $29,751, as compared with $65,471 for the preceding year. The $192,500 common dividend compares with $82,500 for the year ending January 31, 1905. The net earnings show an increase of $44,457.

The Northwestern Elevated February daily average was 83,572; increase 4,779.

The South Side Elevated February daily average was 95,077, an increase of 6,904.

The Metropolitan Elevated February daily average was 135,570, an increase of 14,393, making a new monthly record.

Oak Park Elevated February daily passenger average, including transfers, was 48,920; increase 1,771.

PERSONAL MENTION.

MR. J. WARD BLAKESLEE has resigned as assistant superintendent of the Union Electric Light and Power Company, St. Louis, Mo., and has returned to Duquoin, Ill.

MR. F. E. DONOHOE, Chicago representative of the American Electrical Works, has come to New York as sales agent to take the place of Mr. W. J. Watson, who has resigned to enter the real estate field. Mr. Donohoe is succeeded at Chicago by Mr. G. H. Hammond, who was formerly associated with Mr. Donohoe in that city. Mr. Donohoe's headquarters in New York will be at the Havemeyer Building.

MR. WESLEY WENTWORTH has been appointed general manager of the Houston (Tex.) Electric Company. Mr. Wentworth comes from Dallas, where for the last nine months he has been superintendent of the Dallas Street Railway Company. Mr. Edward C. Reichardt, cashier of the Houston Electric Company, has been appointed assistant to the treasurer of the Fort Worth Street Railway and of the Fort Worth-Dallas Interurban Railway.

MR. JOHN F. WALLACE, formerly chief engineer of the Panama canal commission, is to become president of a new company which is being organized by George Westinghouse. The details of the new company will not be completed for some time, but it is announced that the new corporation will be a large one and of considerable importance in the electrical world. Before joining the Panama canal commission Mr. Wallace was chief engineer of the Illinois Central Railroad.

MR. ARTHUR GIESLER, late chief engineer and designer of hydraulic installations for the Platt Iron Works Company, of Dayton, Ohio, has established himself in New York with offices at 170 Broadway as a consulting engineer and will devote himself to the specialty of hydro-turbine power plants and hydro-turbine pumping stations. Mr. Giesler has been actively identified with water-wheel design and installation for practically his entire life. Beginning in 1869, he erected, at Dirschau, Prussia, for Professor Fink, of Berlin, Fink's first reaction turbine, equipped with what is known as the "Fink Gate." Of German birth and education, coming to America in 1882, Mr. Giesler entered the employ of the Stillwell-Bierce & Smith-Vaile Company, becoming shortly assistant superintendent and subsequently superintendent of works and chief engineer, which position he retained up to the date of his resignation from the Platt Iron Works Company. Making frequent visits to all the turbine manufacturers of Europe, he has had exceptional opportunities to avail of their cumulative experience, and being a French as well as a German scholar has been able to keep up to date in the literature of his specialty in these languages as well as in English.

ELECTRIC LIGHTING.

EVANSVILLE, IND.—Cannelton will rebuild its electric light plant.

FORT DODGE, IOWA—The Newton & Northwestern company has purchased the Fort Dodge street-railway system.

PERTH AMBOY, N. J.—The Citizens' Electric Light, Heat and Power Company has awarded the contract for a new building.

LACONIA, N. H.—The Laconia Electric Light Company has ordered a 250-horse-power engine to meet the demand for power.

MOUNT UPTON, N. Y.—It is proposed to establish an electric plant at Rockwell's Mills to light that place and Mount Upton.

TRENTON, TENN.—The Trenton city council has concluded the purchase of the electric plant owned by Messrs. Keenan & Wade.

ANDERSON, S. C.—The Savannah River Power Company has let to the J. F. Gallivan Building Company the contract for building the dam at Gregg Shoals.

EDWARDSVILLE, ILL.—The Coffeen town board has granted an electric light franchise to Frank C. Edwards, the plant to be in operation within six months.

OLYPHANT, PA.—The Blakely borough council, at an election held February 20, voted to spend $8,000 for a new engine and dynamo to be installed in the borough electric plant.

SPRINGFIELD, OHIO—A. E. Locke, of Boston, representing the Widener-Elkins and Kelsey-Schoepf interests, bought the Dayton, Springfield & Urbana Interurban Line at the receiver's sale, paying $600,000 for it.

GLENS FALLS, N. Y.—The Greenwich trustees have awarded the contract for lighting the streets for five years from July 1 next to the Consolidated Electric Company, of that place, for $50 per lamp per year. The present price is $37.50.

NEVADA CITY, CAL.—In a short time work will be under way on the electric power-house in which the California Gas and Electric Company is to erect on Little Deer creek. It is expected that the plant will be ready for use before the fall.

ASBURY PARK, N. J.—At a meeting of the directors of the Atlantic Coast Electric Light Company in Philadelphia, S. F. Hazelrigg was elected president and G. B. Cade treasurer. J. G. Campbell will continue as superintendent of the light plant.

OKOLONA, MISS.—The municipal electric light plant is installing additional equipment, as follows: a forty-five-kilowatt Bullock alternating-current generator, driven by an eleven by twelve Lyconing engine, and a twenty-five-light Jandus series alternating-current system on the meter basis.

SANTA FE, N. M.—The Magellen Power and Transmission Company has filed incorporation papers with a capital stock of $1,000,000 and headquarters at Silver City. The principal stockholder is Blakely Graham, of Denver. The company intends to develop the water power of the Gila river in northwestern Grant county.

CHARLOTTE, N. C.—The contract for the digging of the canal that is to carry the water from the river to the power-house at Great Falls, S. C., has been let by the Southern Power Company to the Simons Mayrant Company, of Charleston, S. C. The canal is to be one and one-eighth miles in length, twenty feet deep and 180 feet wide.

FOSTORIA, OHIO—Assurances are given that the proposed Fostoria-Fremont electric line will be built in the spring. The company is financed by Fostoria and outside capitalists and is backed by the Western Ohio. This line will be the direct connecting link between Cincinnati and Cleveland. The contracts will be let soon and work started by April 1.

WINCHESTER, VA.—The Winchester Electric Light Company has sold to the Winchester & Washington Railway Company its electric lighting plant in Winchester for $12,000. The latter company is building a $200,000 plant at Millville, Jefferson county, W. Va., and has secured a franchise for lighting and electric power in Winchester, Berryville, Charlestown and other nearby towns.

ALLENTOWN, PA.—At a meeting of the stockholders of the Mauch Chunk Heat, Power and Electric Light Company the following directors were elected: J. S. Wentz, Lafayette Lentz, William O. Lentz, Frederick Bertolette, Jonas Sondheim, George W. Twining, John L. Wentz, C. A. Rex, David Ross, H. B. Price, M. S. Kemmerer, Leonard Yaeger and John B. Price.

OGDEN, UTAH—J. F. McCarron, to whom a franchise for an interurban road through Weber county was granted last fall, and who had previously secured a similar franchise from Salt Lake through Davis county, says his road will be the first interurban line to connect Salt Lake and Ogden, and that work will begin within the time limit, or some time in May.

TROY, N. Y.—The control of the Granville Electric, Gas and Fuel Company has passed to Glens Falls men. The board of directors organized by electing the following officers: president, M. O. Kasson; vice-president, F. D. Howland; secretary, B. C. Higley; treasurer, W. J. Gallagher. The plant is supplying light in Granville, Middle Granville and to the quarries.

LOUISVILLE, KY.—Plans are being made by the constructors of the electric line from Shelbyville through Eminence to the Ohio river opposite Madison, Ind., for the construction of a similar road from Bowling Green to Central City. These constructors, who are headed by Liebler & Company, of New York, have completed their plans for the electric line from Shelbyville to the Ohio river.

LANSING, MICH.—The Michigan Power Company, the corporation which has succeeded the Piatt Heat and Power Company, has selected the Pinckney property at Grand and Ottawa streets as a site for its central power-house and steam-heating plant, which will cost $250,000. Six thousand horse-power will be developed at this plant, aside from 12,000 horse-power at the various dams in Grand river owned by the company.

ADEL, GA.—The Adel Electric Light and Power Company has been organized with William Scandrett, president; J. T. Wilkes, vice-president; and J. J. Parish, Jr., secretary-treasurer. The board of directors includes the above-named officers, also J. H. Kennon, W. H. Baskins, R. B. Young, S. A. Juhan, S. A. Parish and L. P. Booth. The company will at once commence preliminary work and hopes to have the town lighted within a few months.

YORK, PA.—As a result of certain charges made against some of the directors of the Merchants' Electric Light Company, of York, the company has been placed in the hands of a receiver. H. B. Wasbers, treasurer of the company, has been appointed temporary receiver until a full investigation of the charges can be made by the court. The Merchants' Electric Light Company was organized five years ago by prominent business men and merchants of York.

KOKOMO, IND.—A stock company has been organized at New London, Howard county, and will construct a dam across Honey creek and establish an electric plant to furnish light for the town and for the farmhouses in the adjacent county. The dam will back the waters of Honey creek among the hills and form a lake that will cover twenty-five acres, and that will have a depth of from five to twenty-five feet. It is the intention of the stock company to establish a summer resort at the lake.

SCRANTON, PA.—The Lackawanna Light Company, formerly the West Scranton Light, Heat and Power Company, has purchased a tract of land about two and one-half acres in extent on Sanderson avenue, between Glenn and Walnut streets and extending to the Delaware & Hudson Railroad. The consideration is said to be $7,000. Upon this tract will be located the power-house of the company, which will be constructed at a cost of $20,000. In this building will be placed machinery valued at $100,000.

MENOMONIE, WIS.—K. Rosholt, of Eau Claire, has purchased from the Knapp-Stout interests the dam and flour mill located at Chetek. With the purchase go all water rights and privileges. A water reservoir of twenty square miles is included in the deal. The Chetek dam develops over 1,000 horse-power. It was built about twenty years ago, and a few years ago was rebuilt. The purchase price was not learned, but the original cost to the Knapp-

Stout people years ago was between $75,000 and $80,000. Mr. Rosholt purposes to generate and distribute electric current.

KEARNEY, NEB.—The village board of Gibbon has granted J. H. Davis & Son a franchise for the construction and maintenance of an electric light and power plant in that village. The life of the franchise is twenty years. The grantees must file their acceptance of the same within ninety days. Failure to supply the village with lights for a period of thirty days forfeits the franchise. The chairman of the board is authorized to enter into a contract with the grantees for furnishing lights for the streets of Gibbon. Work will be commenced on the new plant at once.

TRENTON, N. J.—The United Missouri River Power Company has filed a certificate of incorporation in the office of the secretary of state. The authorized capital stock is $5,000,000. The incorporators are R. R. Higgins, Samuel Hartman and E. G. Graves, all of New York. The company is to purchase, improve, sell, supply and convey water and water power and electricity. The Butte Electric and Power Company has filed a certificate with the secretary of state, increasing its capital stock from $3,000,000 to $6,000,000. The stock is to consist of 60,000 shares of the par value of $100 each, of which 10,000 shares shall be five per cent preferred stock and 50,000 shares common stock. The company was incorporated May 31, 1901.

ELECTRIC RAILWAYS.

ATCHISON, KAN.—At the annual meeting of the Atchison Railway, Light and Power Company all of the officers were reelected.

ALBANY, N. Y.—The state board of railroad commissioners has authorized the Auburn & Syracuse Electric Railroad Company to increase its capital stock from $1,500,000 to $2,000,000.

HAZELTON, PA.—Estimates are being obtained for the construction of a new trolley road from Hazelton to Mauch Chunk by way of Weatherly, a distance of about twenty-four miles.

AKRON, OHIO—The Barberton council has granted a franchise to the Barberton, Wadsworth & Western Electric Railway Company for a period of twenty-five years. The company expects to begin operations at once.

CLEVELAND, OHIO—General Manager J. F. Stout, of the Lake Shore Electric, announces that the company expects to spend about $300,000 in improving the line between Lorain and Cleveland. This portion will be double-tracked.

SPRINGFIELD, OHIO—J. E. Locke, of Boston, representing the reorganization committee of bondholders, has purchased for the Morgan-Elkins-Dolan-Schoepf syndicate the Columbus, London & Springfield Electric Railway for $250,000.

VICKSBURG, MISS.—It is announced that as soon as authority is granted by Congress to lay track over the government road to the National Cemetery an electric railway will be built to the village of Walters, two miles north of Vicksburg.

WICHITA, KAN.—A company to build an interurban railroad from Wichita to Geuda Springs, connecting Wellington, Winfield and Arkansas City with Wichita, may be formed within a short time among the business men of Wichita.

PENNSBURG, PA.—The Souderton-Skippack syndicate will build an extension from Lederachsville through the Perkiomen valley. It is expected that later on the Boyertown-Palm trolley line will connect with the Souderton-Skippack road at Pennsburg.

LINCOLN, ILL.—The Springfield & Northwestern Railway Company has elected directors as follows: M. G. Linn, Sigmund Livingstone, W. S. Harwood, C. M. Harland, D. H. Sawyer, W. D. McKinley, T. B. McCauley, L. E. Fisher and G. M. Mattis.

SAN DIEGO, CAL.—It is stated that the railroad running from San Diego to National City and Tia Juana will be converted into an electric line. Power will be supplied by the San Diego Electric Railway Company. Both the roads are owned by Spreckels interests.

SPOKANE, WASH.—A plan is on foot to build an electric road from Oroville, southeast through Loomis, Sunlahekin valley, and on to Conconnully, the county seat of Okanogan county. It is stated that eastern parties have expressed their willingness to back this enterprise.

MONTREAL, CANADA—The directors of the Montreal street railway have set aside $1,000,000 for the construction of the new power-house in the east end of the city, and have awarded a contract for 6,000 tons of eighty-six-and-a-half-pound T-rails to be delivered in May.

NEW YORK, N. Y.—At the annual meeting of the stockholders of the Long Island Consolidated Electrical companies the retiring board of directors was reelected, with the exception of S. M. Prevost and W. F. Potter, both deceased, who were succeeded by Joseph F. Keany and W. G. Oakman.

VANCOUVER, WASH.—An electric railway, traversing the farming section of Clarke county, is to be installed within a short time, according to the announcement of the Vancouver & Suburban Railway Company. The projected line is to be forty miles in extent, when all branches are built.

MILWAUKEE, WIS.—The Milwaukee Heat, Light and Traction Company has begun condemnation proceedings to gain possession of a right of way not exceeding 100 feet in width and suitable for building and operating a double-track electric railway from North Milwaukee to Cedarburg.

CANON CITY, COL.—F. S. Granger, of San Jose, Cal., who has secured franchises for an electric interurban system between Florence and Canon City, states that he will build west from Canon City, along the tops of the cliffs forming the Royal gorge, bridging the chasm with a suspension bridge.

GRAND RAPIDS, MICH.—At the annual meeting of the Grand Rapids Railway Company these directors were reelected: C. M. Clark, Philadelphia; L. J. Rindge, Benjamin S. Hanchett, Anton G. Hodenpyl, New York; W. H. Anderson, William Judson, J. Boyd Pantlind, Thomas F. Carroll and John A. Covode.

NEW YORK, N. Y.—Queens borough is to have an elevated railroad running through at least two sections of the borough. The Brooklyn Rapid Transit Company has purchased ground at Middle Village, and work will begin shortly extending the Ridgewood line from the old Brooklyn city line to Middle Village.

PITTSBURG, PA.—A trolley road will be built in the near future by Pittsburg capitalists and will connect the Monongahela river at Brownsville with the Ohio river at Wellsburg, W. Va. The line to be built will be about fifty-six miles long. Charters for the necessary right of way have been secured with one exception.

MORGANTOWN, W. VA.—The council of Morgantown has passed favorably upon the application of the Dunkard Valley Railway Company for a franchise to use certain streets of Morgantown. This action ensures the immediate construction of a trolley line, forty miles in length, between Morgantown and Mannington, W. Va.

NEW BEDFORD, MASS.—The stockholders of the Dartmouth & Westport Street Railway Company have voted to ask the railroad commissioners for authority to increase the capital stock of the company by an amount not to exceed $175,000, to take care of the expenditures for double-tracking the road between New Bedford and Fall River.

TRENTON, N. J.—Franchises have been granted the Trenton, Hamilton & Ewing Traction Company by the board of freeholders to construct and maintain a trolley road from Trenton Hamilton square and to Trenton Junction, and also to extend the Trenton street railway lines in the direction of Allentown at a point near Crosswicks.

BALTIMORE, MD.—Philadelphia and New York capitalists are interested in a proposed project for the Susquehanna Power Company, when its works are completed at McCall's Ferry, to supply electricity to the Maryland & Pennsylvania Railroad, now operated by steam. The plan also includes the extension of the road to Philadelphia.

WABASH, IND.—An extension of the Wabash Valley traction system will be made along the line of the old Wabash and Erie canal. The plan is to parallel the Wabash railroad from Fort Wayne to Toledo, Ohio, ninety-five miles, connecting at Toledo with all the Ohio interurban systems and forming a direct line from Detroit to Indianapolis.

EL PASO, TEX.—Kansas City capitalists have made application to the El Paso city council for a franchise for an interurban electric

railroad to operate north through Mesilla valley in New Mexico, 125 miles, and south through the El Paso valley of Texas, forty miles. Power for the line will be furnished by water from the Great Eagle irrigation dam.

MILWAUKEE, WIS.—John I. Beggs, of Milwaukee; Silas W. Burt and Edwin M. Bulkley, of New York, have been reelected directors of the Milwaukee Electric Railway and Light Company. L. W. M. Cromwell, C. W. Wetmore and E. M. Bulkley, all of New York, were chosen to succeed themselves as directors of the Milwaukee Light, Heat and Traction Company.

NEW HAVEN, CONN.—C. W. Blakeslee & Sons, of New Haven, have been awarded the contract to build the new trolley that is to be constructed between Naugatuck and Seymour. The new line, when completed, will be ten miles long and is the connecting link for the trolley system in the Naugatuck valley. The new line is being built by the Connecticut Railway and Lighting Company.

HUNTINGTON, N. Y.—It has been learned on very excellent authority that it is the intention of the Long Island Railroad Company, or an allied interest, to begin within sixty days the work of constructing a cross-island trolley line to connect Huntington with Amityville and Babylon. This line will run through the villages of Melville and Farmingdale, and will form a connecting link which has been greatly desired for many years.

BELOIT, WIS.—The Rockford, Beloit & Janesville Electric Railroad, said to be one of the finest interurban properties in the country, has been sold by John Farson, of Chicago, who lately purchased it, to the Rockford Street and Interurban Railway Company. The Rockford, Beloit & Janesville line is fifty-six miles long and connects the three cities named. The Rockford company already controls the other lines coming into that city.

ALLENTOWN, PA.—The stockholders of the Slate Belt Electric Street Railway Company have elected the following board of directors: T. M. Dodson, J. J. McKee, Alvin Hill, Geo. H. Wolle, C. A. Wolle, of Bethlehem; G. A. Schneebeli, of Nazareth; James Thomas and C. R. Horn, of Catasauqua, and A. S. Keck, of Allentown. The new board organized by electing G. A. Schneebeli, president; R. B. Keys, secretary, and C. A. Wolle, treasurer.

COLUMBUS, OHIO—The Central Market Railway, the only Columbus independent street car line controlled by the Appleyard syndicate, has been sold to the Elkins-Widener syndicate, of Philadelphia, through A. B. Locke, of Boston, who represented the reorganization syndicate, for $150,000, the upset price. The Columbus, Grove City & Southwestern Railway has been sold to the same interests. There was but one bid, $35,000.

MINERAL WELLS, TEX.—The Mineral Wells city council has granted a franchise for an electric street car line to Major G. B. Beardsley, of Louisiana. The construction is to begin within ninety days. Major Beardsley has associated with him in the enterprise Colonel J. L. Breathwit, of the Interstate Investment Company, of Shreveport. The sheds and power-house are to be built in the south part of the town and the main line is to run north and south.

HILLSBORO, ILL.—Articles of incorporation have been placed on file for the Mattoon, Shelbyville, Pana & Hillsboro Traction Company, organized to build an interurban electric line from Hillsboro to Mattoon. The first board of directors is composed of the following persons: W. R. Patton, I. B. Craig, A. W. Treat, A. T. Callison, John W. Yantis, Edward Foster, John W. Kitchell, W. O. Wilcox, W. N. Grimes, Robert Johns, W. A. Young, Arthur Kinkaid and Albert M. Howell.

BUFFALO, N. Y.—The Dunkirk & Fredonia Street Railway Company, with its three miles of street railway connecting Dunkirk and Fredonia, and with a steam distributing plant, an electric light plant and a gas plant in Fredonia, has been sold for $375,000, $100 per share being paid for the stock and the bonded indebtedness of $100,000 being assumed by the purchaser, who is H. W. Noble, of Detroit. Mr. Noble is supposed to be acting for the Buffalo, Dunkirk & Western interests.

MADISON, WIS.—A deal has been closed through the efforts of President Wetzel, of the Wisconsin Dells company, whereby his company, the Spooner power interests, and the Kilbourn-Devils Lake Electric Railroad Company have been consolidated and will do business as one company under one management, with Phil Wetzel at the head. The Wisconsin Dells company waived its objection to a closed bridge at Portage, and the war department has forwarded the permit granting the privilege of a closed dam at Kilbourn.

BOISE, IDA.—At a recent meeting of the Boise Valley Electric Railroad Company Dr. H. P. Ustick resigned as president, and was succeeded by Robert Noble, and Alex Ross was elected secretary. The company will issue $1,000,000 bonds. A market has been secured for the bonds, but none will be issued until the eight miles now under construction have been completed, when bonds for a sufficient amount to build the road through to Caldwell will be sold. A contract has been closed for power for the entire system, of which the Caldwell road is the first unit.

MINNEAPOLIS, MINN.—At the annual meeting of the stockholders of the Twin City Rapid Transit Company in Elizabeth, N. J., the retiring directors were reelected. In pursuance of a resolution adopted at the annual meeting a year ago the board of directors was divided into three classes and the directors assigned as follows: for three years, Thomas Lowry, C. G. Goodrich and Clinton Morrison; for two years, W. H. Goadby, William A. Read and Charles Hayden; for one year, Horace Lowry, John Kean and M. D. Munn. The directors organized by reelecting the former officers.

PORTLAND, ORE.—Several hundred men are at work along the right of way of the Oregon Water Power and Railway Company between Cedarville and Troutdale, according to O. D. Wolf, who has a contract for grading a portion of the line. The extension of the line is eight and one-half miles long, and the work of grading is to be pushed as rapidly as possible. The terminus of the new line is to be on the banks of the Columbia at Troutdale, where a ferry will be established to connect with the north bank. The line will also open up a country that has recently been cleared, and which is within a few hours' ride of Portland.

ASHTABULA, OHIO—The stockholders of the Pennsylvania & Ohio Electric Railway Company held their annual meeting recently. The reports of the officers for the year were submitted, showing the largest amount of business ever done by the line. The stockholders elected the following board of directors: Thomas Fricker, E. L. Hills, Ashtabula; W. F. Stanley, Conneaut; Thos. McGovern, Geneva; A. F. Galpin, Frank Fortune, Charles Lawyer, B. W. Baldwin, Jefferson; Charles O. Evarts, Cleveland. The directors elected officers as follows: president, Thomas McGovern; vice-president, W. F. Stanley; secretary and treasurer, A. F. Galpin; superintendent, P. Wardman.

BUTLER, PA.—The last details of the purchase of the Butler Passenger Railway Company by the Pittsburg & Butler Street Railway Company have been completed. Four hundred thousand dollars, half in stock in the Pittsburg & Butler company, and half in cash, is said to have been paid for the Butler company and its property, netting a profit of $200,000 to the owners. A mortgage of the Butler Passenger Railway Company to the Pittsburg Trust Company for $500,000 has also been placed on record. A certificate issued by Secretary of the Commonwealth McAfee to the Butler Passenger Railway Company, allowing it to extend its lines over Polk, West Pearl, West North, West Clay and Broad streets, Butler, was also recorded.

ST. LOUIS, MO.—The promoters of the St. Louis, Hillsboro & Southern, the proposed electric road from St. Louis to Hillsboro, Mo., have announced the completion of the financing and the letting of contracts for building the line. The franchises and right of way have been secured, the surveys completed and construction work is to begin March 1. The line to Hillsboro, the county seat of Jefferson county, forty miles south of St. Louis, is planned as the first link in a through trolley road to the Thebes bridge, 140 miles from St. Louis, by way of Potosi and Bismarck, with branches and connections extending through Salem to Cabool, in Texas county. The road south from Hillsboro is to be built by a separate company, not yet organized.

TELEPHONE AND TELEGRAPH.

NEW CASTLE, PA.—Farmers of New Bedford are organizing an independent telephone company.

LEBANON, PA.—The United Telephone and Telegraph Company has completed a line to Schaefferstown.

TEXARKANA, ARK.—An exclusive franchise has been granted to the independent telephone company.

DENVER, COL.—The Colorado Telephone Company has completed a branch toll-line system from Del Norte to Creede.

WILKESBARRE, PA.—Extensive improvements have been made to the operating department of the People's Telephone Company.

AMERICAN FORK, UTAH—The Utah Independent Telephone Company has opened its exchange at American Fork with 110 subscribers.

MINNEAPOLIS, MINN.—The Northwestern Telephone Exchange Company has secured control of the Minnesota Central Telephone Company.

PHILADELPHIA, PA.—The new telephone line planned by the Mountain Company, from Boyertown to Huff's Church, Pa., will be erected soon.

ST. JAMES, MINN.—Plans are now on foot for the building in the early spring of eight or nine farmers' lines by the St. James Telephone Company.

SCHENECTADY, N. Y.—The extension of the telephone system of the Hudson River Telephone Company has been completed in the town of Glenville and vicinity.

SUNNYSIDE, WASH.—The Christian Cooperative Telephone Association has signed a contract with the Pacific States Telephone Company connecting the systems after March 1.

DENVER, COL.—The Colorado Telephone Company will erect a new one-story exchange building on Gallup street, to cost $10,000. Construction work will be started immediately.

BLUFFTON, OHIO—The new officers of the Bluffton Mutual Telephone Company are as follows: president, J. Sheller; vice-president, J. C. Welty; secretary, A. C. Diller; treasurer, John Bixel.

TRENTON, N. Y.—The Delaware & Atlantic Telegraph and Telephone Company has been given authority to lay conduits on the county bridge on Greenwood avenue by the board of freeholders.

CHARLOTTE, N. C.—The Southern Bell Telephone and Telegraph Company has acquired the Independent telephone system at Rockingham and the service will be rearranged, improved and extended.

MILWAUKEE, WIS.—The Wisconsin Telephone Company will erect an addition to its south side exchange, Hanover and Washington streets, at a cost of $20,000. It will be two stories high, constructed of brick.

ALBUQUERQUE, N. M.—The long-distance telephone line of the Colorado company, which connects Albuquerque with Santa Fe, Las Vegas, Pueblo, Colorado Springs, Denver and Salt Lake City, has been completed to Albuquerque.

POMEROY, WASH.—The Ewartsville Telephone Company, owned and operated by farmers, will be extended to Pomeroy and Garfield county from Pullman and Colfax. From Pomeroy the line will be extended to Dayton and Walla Walla.

MORRICE, MICH.—The farmers' telephone lines, east of Morrice, have been united into the West Antrim Telephone Company. Officers have been elected as follows: A. L. Beard, Morrice, president; W. Waters, Antrim, secretary; P. Sardan, Antrim, treasurer.

UTICA, N. Y.—The Central New York and Empire State Telephone companies intend to expend $1,500,000 in the improvement of their various lines this year. This will be distributed over the eighteen counties in which the companies do business.

NEW YORK, N. Y.—Plans have been filed for a new three-story and basement exchange to be built for the New York Telephone Company at Convent avenue and One Hundred and Forty-sixth street. It is to be called the "Audubon Central" station and is to cost $110,000.

DETROIT, MICH.—The Michigan state telephone directors have approved estimates of expenditures for improvements and extensions for 1906 aggregating $1,260,000. About 20,000 telephones will be installed. Dudley E. Waters, president of the Grand Rapids National, has been elected vice-president to take the place of Truman M. Newberry.

CHARLOTTEVILLE, N. Y.—At the annual meeting of the Charlotteville Telephone Company John Allen was reelected president; Luke Colliton, vice-president; Hiram Rifenbark, treasurer; Dr. M. Bruce, secretary; directors, C. E. Nichols, R. G. Nichols, Samuel Lape, James H. Brown, John Allen, Luke Colliton, Dr. M. Bruce. A dividend of seven per cent was declared.

GREEN BAY, WIS.—At a meeting of the directors of the Fox River Valley Telephone and Telegraph Company it was decided to build seventy-five miles of toll lines in various directions, work to begin in the spring. Frank Carswell, a former Wisconsin telephone man, but of late local manager for the Valley company, has been appointed general manager of the entire system.

BERTHOUD, COL.—At the annual meeting of the Consolidated Home Supply Ditch and Reservoir Company a committee consisting of C. C. Clark, Will Bader and John Coleman was appointed to confer with eastern telephone construction companies with a view of building an independent telephone line along the route of the company's ditch, connecting Berthoud, Loveland and Johnstown.

PITTSBURG, PA.—A large increase in the use of the telephone during the past year is shown by the annual report of J. A. Connell, contract agent of the Central District and Printing Telegraph Company. During the year 12,232 new stations were added in the Pittsburg district and 11,717 in the districts under control of the Pittsburg management. A year ago there were 101 farmers' lines with 774 stations on them, where now there are 280 lines with 2,173 stations.

ONEONTA, N. Y.—The Davis and Rose Telephone companies have consolidated, and in the future will be operated under one management. The Worcester exchange will be rebuilt and rural lines run to Decatur, South Valley, East Worcester and other points. An exchange is being installed at Pleasant Brook, and the line from Schenevus to Westville has been completed. These lines are all connected with the Oneonta Telephone Company. The Oneonta Telephone Company has completed a new line from Milford to Westville.

PITTSBURG, PA.—At the annual meeting of the stockholders of the Pittsburg & Allegheny Telephone Company the following directors were reelected: J. G. Splane, John S. Weller, Robert C. Hall, D. P. Reighard, J. M. Clapp, R. H. Binns, H. B. Beatty, George R. Webb and Ralph E. Flinn. Following the organization of the board and reelection of officers, an appropriation of $750,000 was made to carry on new construction work. No statement of earnings was given out, although the profits for the year were said to have been satisfactory. It was reported that 55,000,000 messages were handled during 1905, and that long-distance business had increased 200 per cent over 1904.

ROCHESTER, N. Y.—At the annual meeting of the stockholders of the Rochester Telephone Company the following directors were elected: George R. Fuller, Albrecht Vogt, H. Wheeler Davis, Gustav Erbe, George F. Roth, Rufus A. Sibley, Jacob Gerling, J. Foster Warner, Edward W. Peck, Louis Griesheimer, John C. Woodbury, J. Craig Powers, Joseph W. Taylor, Frederick W. Zoller, George Seager, William T. Farrell, John P. Haley, Charles G. Vickery, James Barry and Frank T. Byrne. At the meeting of the directors these officers were elected: president, George R. Fuller; vice-president, John C. Woodbury; secretary and treasurer, J. W. Taylor. The annual meeting of the Independent Telephone Securities Company, a subsidiary company of the Rochester Telephone Company, was also held. Directors were elected as follows: George R. Fuller, John C. Woodbury, Frederick W. Zoller, Charles H. Poole and T. Harvey Ferris. The directors elected these officers: president, George R. Fuller; vice-president, John C. Woodbury; secretary and treasurer, Frederick W. Zoller. The Independent Telephone Securities Company was organized as a holding company, to take over the various independent telephone properties acquired by the Rochester Telephone Company.

INDUSTRIAL ITEMS.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has removed its Philadelphia office from 1121 Walnut street to 550 Drexel Building.

THE DEAN ELECTRIC COMPANY, Elyria, Ohio, has published a folder descriptive of the harmonic converter, a new party-line ringing machine. This is described in folder No. 5.

THE HELIOS MANUFACTURING COMPANY, Bridesburg, Philadelphia, Pa., announces that the Bastian Meter Company, of England, claims that eighty per cent of all the meters used in Australia are of the Bastian electrolytic type.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, manufacturer of Triumph electric light and power machinery, is calling attention to its complete line of apparatus and will be pleased to send full information and illustrations upon request.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has ready for distribution a number of new bulletins superseding those previously issued, to take regular place in the perpetual catalogue. The company will be pleased to send these bulletins to any one interested upon request.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., has published a neat catalogue descriptive of the Wesco solid-back transmitter. Each element of the design and construction is taken up in detail, the text being supplemented by carefully arranged reproductions of the various parts.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., in catalogue No. 129 describes and illustrates machinery for cement making. This takes up in detail rock-breakers, crushers, driers, kilns, ball mills, tube mills, elevators and conveyers. This company is the manufacturer of machinery for every stage in cement making by either the wet or dry process.

THE ELEKTRON MANUFACTURING COMPANY, Springfield, Mass., has published a catalogue giving a complete story of the general design and the electrical and mechanical features of its type H motors and dynamos. This company manufactures electric elevators, dynamos, motors, electric dumbwaiters, organ-blowing outfits, pumps, rheostats, ventilating fans and other forms of electrical machinery.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., has ready for distribution bulletin No. 15, superseding bulletin No. 5. This gives a description of the central energy telephones made by the company. The text is supplemented by numerous half-tone illustrations, the typography and presswork being in the usual handsome style of all the literature issued by the company.

THE STANDARD WELDING COMPANY, Cleveland, Ohio, is distributing several pamphlets descriptive and illustrative of its various products. One pamphlet deals with welding by electricity, showing electrically welded automobile parts and miscellaneous electric welding. Another describes and illustrates seamless steel rings welded by electricity, seamless steel tubing, and tubes and rings of special character.

THE POPE MOTOR CAR COMPANY (Waverly department), Indianapolis, Ind., has published a handsome booklet entitled "Profitable Electric Garaging." The first page bears the following quotation: "A book bearing testimony of the experts and containing facts and figures for the enlightenment of the automobile dealer, issued by way of encouragement in answer to the question 'is electric garaging profitable.'"

McLEOD, WARD & COMPANY, 27 Thames street, New York city, is distributing a hanger showing a number of different styles of portable desk and fixture lamps. These include single and double-cylinder desk lamps and portables, pulpit lamps, bookkeepers' desk lamps, picture lamps, hemispherical reflector lamps and an illustration of the new Ward "Doublejoint." This double joint gives free play to the movement of the light in any direction.

THE FREVERT MACHINERY COMPANY, 18 Dey street, New York city, has opened a salesroom where it will carry a complete line of new and second-hand metal-working tools and machinery of every description. The company is also manufacturing a line of newly designed hand-power traveling cranes, trolleys, hoists and overhead tracks. Mr. H. S. Frevert, who is at the head of this company, has had a wide experience in the machine tool business.

THE C. H. WHEELER CONDENSER AND PUMP COMPANY, Philadelphia, Pa., announces that there has been some confusion and delay in the transmission of mail matter and orders intended for the company, owing to the similarity between its corporate title and that of another concern. In order to avoid a recurrence of such confusion and delay it has been decided to change the corporate name to the C. H. Wheeler Manufacturing Company, this taking effect March 1, 1906.

THE JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., is distributing a novel and attractive pamphlet entitled "Some Roebling Products." This pamphlet is illustrated with half-tone reproductions of the applications of Roebling products to suspension bridges, wire rope transmission problems, ship and yacht rigging, hawsers, cableways and tramways, galvanized wire strand, wire rope fastenings, steel-core bell cord, double galvanized telephone wire, copper telephone wire, insulated electrical wires and alligator wrenches.

FRANK B. COOK, Chicago, Ill., announces the award of an order for the complete protector equipment for the new exchange of the Kinloch Telephone Company, St. Louis, Mo. This is said to be the largest single order for protective apparatus that has ever been placed. The Kinloch rack will be the largest single rack in existence. The order calls for 16,000 pairs of protectors, and the type to be furnished by Mr. Cook is of entirely new design. The Kinloch Telephone Company called for an improvement over any existing type of protector, and the apparatus which Mr. Cook will furnish, it is stated, is a departure both in principle and design from any protector now made. The order for the protectors was placed by the Stromberg-Carlson Telephone Manufacturing Company.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

CHARLESTON, W. VA.—The Henry C. Jackson Electric Company, of Parkersburg, W. Va., has been incorporated to conduct a general electrical business. The capital stock is $50,000, and the incorporators are Henry C. Jackson, W. C. du Camps, C. L. Williams, A. C. Adair and J. W. N. Brown, all of Parkersburg.

MILWAUKEE, WIS.—The Signalphone Company, which has purchased the business of the Signalphone Alarm Company, has been incorporated with a capital of $100,000 and will manufacture signal apparatus on a large scale. The patent which the new company controls is known as the interlocking system, which permits of sending a fire or a police alarm or telephone message over the same wire without interruption from either source. The incorporators are H. O. Brumder, Dr. H. V. Wurdeman and John Stouthammer, all of Milwaukee.

OBITUARY NOTICE.

MR. FRANKLIN BROOKS, partner in the firm of Eugene Munsell & Company, New York city, died at his home in Elizabeth, N. J., on the morning of Monday, March 5. He had returned Saturday from Hot Springs, N. C., where he went to obtain relief from rheumatism. He was born fifty-one years ago in San Francisco. His father was interested in a mica mine in North Carolina, and the son spent several years there and became an expert on mica. He associated himself with his cousin, Eugene Munsell. He was vice-president of the Mica Insulator Company and director in two mica mines in North Carolina. He was also interested in mica properties in India and visited the mines there two years ago. He was president of the Mattano Club in Elizabeth.

EDUCATIONAL.

UNIVERSITY OF WISCONSIN--The college of engineering of the University of Wisconsin, Madison, Wis., has received a Curtis steam turbine, which is being installed in the mechanical laboratory of the engineering building. The new machine, which is in part a gift of the General Electric Company, will be used for the instruction of students and for experimental work.